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Anderson, Timothy R.

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The recent Defense Mobility Requirements Study determined there was an urgent need for Ready Reserve Force (RRF) ships to meet the sealift follow-on surge requirements. There are three alternatives for acquiring these ships: purchase and convert older commercial ships (inactive RRF), build militarily useful, yet commercially viable ships and lease them to the commercial shipping industry (active RRF), or subsidize the construction of commercial ships with National Defense Features. This thesis conducted a financial analysis of these three alternatives to determine which is the most cost effective. The results of this analysis show that each alternative is a cost effective approach to acquiring ships under different values for the most critical factors: acquisition costs, lease rate and discount rate. Even so, with the current political and economic environment, and the current military 'budget crisis' the inactive RRF presents the only viable alternative for the near future.

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O. D. Moses

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A Financial Analysis for the Acquisition of Ready Reserve Force Ships

by

Timothy R. Anderson
Lieutenant, United States Navy
B.S., U.S. Merchant Marine Academy, 1986

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David R. Whipple, Chairman
Department of Administrative Sciences

ABSTRACT

The recent Defense Mobility Requirements Study determined there is an urgent need for Ready Reserve Force (RRF) ships to meet the sealift follow-on surge requirements. There are three alternatives for acquiring these ships: purchase and convert older commercial ships (inactive RRF), build militarily useful, yet commercially viable ships and lease them to the commercial shipping industry (active RRF), or subsidize the construction of commercial ships with National Defense Features. This thesis conducted a financial analysis of these three alternatives to determine which is the most cost effective. The results of this analysis show that each alternative is a cost effective approach to acquiring ships under different values for the most critical factors: acquisition costs, lease rate and discount rate. Even so, with the current political and economic environment, and the current military 'budget crisis' the inactive RRF presents the only viable alternative for the near future.

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TABLE OF CONTENTS

I. INTRODUCTION

A. BACKGROUND

The dramatic decline in the United States maritime industry over the past thirty years has presented a serious problem for the nation's military sealift capability. Throughout the history of the United States, the military has relied on the nation's commercial shipping industry to transport military equipment and personnel wherever needed. At the end of Operation Desert Shield/Storm the need for a larger, more responsive military sealift capability was clear. As the U.S. military continues to change in future years (i.e., smaller base forces, less forward deployment and less overseas basing) and the U.S. maritime industry continues its decline, this need will only intensify.

In response to Congressional requests, the Department of Defense is conducting the Defense Mobility Requirements Study (MRS). One emphasis of this study is to assess the need for additional sealift ships, in light of the recent experience in Operation Desert Shield/Storm. The first part of the MRS, which was recently released, dealt with the topic of surge shipping requirements. The MRS concluded that acquiring additional Roll-on/Roll-off (RO/RO) vessels was of the utmost importance to help make-up the shortfall in surge shipping. Due to its military usefulness, this

type of vessel proved to be very important during Operation Desert Shield/Storm.

In conjunction with the MRS, the Navy has conducted an analysis, entitled "Strategic Sealift Implementation Plan" (dated 21 September, 1992), to determine the best method of acquiring the ships needed to meet the MRS requirements. From this analysis, two different prospective ship designs have emerged: a large (950 feet), 24 knot RO/RO to be used for prepositioning and surge sealift shipping, and a medium (700 feet) 20 knot potentially commercially viable RO/RO to be used in meeting the additional follow-on surge requirements identified in the MRS. In June of 1992, the Joint Requirements Oversight Council (JROC) approved the initial design of the large 24 knot RO/RO vessel, but deferred a decision on the medium sized, 20 knot RO/RO vessel pending further analysis of its commercial viability and military utility.

Under the current analysis structure, there are essentially three different alternatives the Navy can take in acquiring the additional sealift ships needed to meet the shortfall in follow-on surge capability:

- Purchase older obsolete ships from the commercial shipping industry, convert the ships to enhance their military capabilities, and then lay-up these ships in the

Ready Reserve Force (RRF). This alternative is presently used.

- Build militarily useful, yet commercially viable ships in U.S. shipyards and then lease these ships to the U.S. commercial shipping industry. These ships would be government owned.
- Have commercial shipping companies construct merchant ships in U.S. shipyards, with the necessary military enhancements (known as National Defense Features). This ship construction would be subsidized by the government through sealift ship construction funds. These ships would be under private ownership and recalled in time of a national emergency or contingency.

B. OBJECTIVES

This thesis is a financial analysis of these three alternatives. Each alternative will be considered based upon both its cost to the government and its present and future enhancement of the nation's sealift capability. Factors that enhance the U.S. maritime industry will also be considered.

The first part of the analysis will look at past and present costs for maintaining and operating the RRF. This analysis will assess the current readiness and capabilities

of the RRF with an emphasis on Operation Desert Shield/Storm results.

Secondly, the three alternatives will be financially analyzed. The structure of the analysis will be based upon the net present value model for capital budgeting decisions and the DOD instruction for Economic Analysis and Program Evaluation for Resource Management (DODD 7041.3). Specifically, uniform annual costs will be calculated for each alternative. Data concerning ship acquisition and conversion costs, maintenance costs, potential leasing income and other auxiliary costs will be provided to estimate the overall financial costs or savings to the government for each alternative. The assumptions concerning the above mentioned costs, revenues and ship useful life for each alternative will be discussed.

Lastly, the results of the financial analysis for each alternative will be compared to determine the most cost effective method for ship acquisition. This comparison will deal with the strong and weak points of each alternative, particularly concerning cost effectiveness versus operational readiness and availability. Non-financial considerations and their effect on future decisions will also be discussed.

C. SCOPE AND LIMITATIONS

This thesis will help determine which of the three alternatives is the most cost effective method for meeting present and future sealift requirements. This study will analyze the overall cost of each alternative, and summarize their benefits and drawbacks. The thesis will also address present and future non-financial issues concerning these alternatives.

This thesis will not address logistics requirements for sealift. This has been established in prior analyses, including the MRS and Strategic Sealift Implementation Plan.

D. ORGANIZATION

The following is an overview of the chapters in this thesis:

- Chapter II will describe the different components of military sealift, including the National Defense Reserve Fleet and the Ready Reserve Force.

- Chapter III will discuss the RRF performance in Operation Desert Shield/Storm, emphasizing lessons learned.

- Chapter IV will present an overview of the recent Strategic Sealift Implementation Plan, including a discussion of the progress in the current strategic sealift ship acquisition program.

- Chapter V will provide an overview of the financial analysis of an active RRF program conducted in the Strategic Sealift Implementation Plan. This analysis is considered further by developing a uniform annual cost analysis of the three alternatives (i.e., inactive RRF, active RRF and NDF). The uniform annual cost analysis is the emphasis of the thesis. The methods, models and assumptions contained in the uniform annual cost analysis will be described in detail. This chapter will conclude with a summary of the results.
- Chapter VI discusses the strengths and weaknesses of each alternative, including additional non-financial considerations. This chapter provides a summary of the overall conclusions of the thesis.

II. MILITARY SEALIFT OVERVIEW

A. INTRODUCTION

In the event of a national emergency or contingency, the U.S. armed forces must quickly move large amounts of military equipment, supplies and personnel to anywhere in the world. Strategic mobility is the transportation of equipment required for deployment, initial support and sustainment of U.S. armed forces overseas. The three elements of strategic mobility are sealift, airlift and prepositioning [Ref. 1: p. 14]. In any contingency or national emergency, prepositioning and sealift will be required to transport the bulk of military equipment and supplies. Throughout the latter 1970's and 1980's the Department of Defense (DOD) emphasized enhancing the nation's sealift position. The ability to quickly deliver military cargo overseas during a national emergency or contingency is of the utmost concern to logistics planners.

This chapter provides a detailed discussion of strategic sealift. The first section presents definitions of the three basic categories of sealift shipping: prepositioning, surge and sustainment. The second section discusses the different components that make up strategic sealift. The third section discusses the history and purpose of the National Defense Reserve Fleet (NDRF), specifically the

Ready Reserve Force. This is followed by a discussion of the specific maintenance and operations of the NDRF, including, management, maintenance, outporting and activations.

B. DEFINITIONS

There are three categories of sealift shipping: prepositioning, surge and sustainment. Prepositioning means that ships are loaded with the necessary military cargo and staged in advance in areas where they will most likely be needed.

Sealift surge requirements are for military unit equipment (UE). This consists of large cargo such as vehicles, tanks, artillery, etc., which are not readily containerized for transport. Surge and follow-on surge involve the bulk of UE used to supply and reinforce any area of overseas operations. Roll-on/Roll-off (RO/RO) ships are best suited for this task. [Ref. 2: p. 10]

Sustainment consists of spares, food and other bulk supplies which can be placed in containers for shipping. This cargo is vital for long term military operations.

In a contingency, such as Operation Desert Shield/Storm, prepositioned ships are the first to arrive in the area. They are followed by the first wave of surge ships carrying essential military hardware and supplies. After the initial

surge ships, follow-on surge ships will start to arrive bringing additional equipment and supplies. Once all necessary equipment has been transported, sustainment cargo arrives. The bulk of sustainment cargo for the deployed forces is provided by shipping from all sources, but mainly U.S. and foreign commercial merchant ships and the re-use of Afloat Prepositioning Force ships (explained in the next section). This shipping is needed to replace daily consumption items and increase in-theater reserves to 60 day levels or more.

C. STRATEGIC SEALIFT

Strategic sealift consists of several components. The following discusses these components:

1. Afloat Prepositioning Force

The Afloat Prepositioning Force (APF) is comprised of the following:

a. Afloat Prepositioning Ships (APS)

These ships are used for non-combat stores and supplies. APS consists of four tankers and seven general cargo ships which carry supplies for the Air Force and Army, and one cargo ship for a Naval Fleet Hospital. These ships are managed by the Military Sealift Command (MSC). They are fully manned and chartered on a three year lease funded by the Army. These ships are prepositioned at Diego Garcia in

the Indian Ocean. They are commonly referred to as PREPO ships.

b. Maritime Prepositioning Ships (MPS)

There are 13 MPS ships organized into three squadrons: five ships at Diego Garcia, four ships in the Western Atlantic and four ships at Guam. Each squadron carries the necessary equipment and supplies for a 16,500 member Marine Expeditionary Brigade (MEB). The squadrons are outfitted with enough supplies for 30 days.

The 13 MPS ships were commercially built using guaranteed government loans and guaranteed contracts. The commercial company is given complete ownership of the ship after 25 years. Additionally, these vessels are manned by civilian crews and have military detachments assigned on board.

2. Fast Sealift Ships (FSS)

This component consists of eight fast SL7 container ships that were purchased and converted to a modified RO/RO configuration at a cost of approximately $827 million. [Ref. 3: p. 14] These ships are used for transporting Army UE. They are maintained in a reduced operating status (ROS). The ships are manned with a reduced crew (10-12 members) and the steam plant is maintained in a 'hot' condition. This ensures that the ships can be activated within four days to help meet initial surge requirements.

3. Follow-on Surge Shipping

There are three sources for follow-on surge shipping. They consist of the following:

a. *Ready Reserve Force (RRF)*

As of August 1990, there were 96 ships in the RRF with a projected increase to 142 ships by 1994. This will include (estimated) 60 dry cargo ships, 32 RO/ROs, 12 auxiliary crane ships, 36 tankers, and 2 troopships. The ships in the RRF are acquired by purchasing obsolete, yet militarily useful, commercial ships, upgrading selected ships from the National Defense Reserve Fleet (NDRF) and transferring previous Navy support vessels. These ships are used to transport Army and Marine Corps resupply equipment.

b. *U.S. Flag Fleet*

Ships operating under U.S. registry (U.S. flag) can be requisitioned by the President of the United States in a national emergency. In addition, ship owners/operators who receive Operational Differential Subsidies (ODS)[1], or Construction Differential Subsidies (CDS) must participate in the Sealift Readiness Program (SRP) (see Appendix C for a discussion of CDS). This program requires that the ship owner/operator provide 50 percent of their fleet for use in

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[1]Operating Differential Subsidies provide the operator of U.S. flag vessels employed in U.S. foreign trade with additional funds to cover the differential costs of operating a ship under U.S. registry as compared to current foreign ship operators. The subsidy is designed to cover any excess amounts incurred for crew wages, insurance, operations and maintenance. This subsidy is designed to help the ship operator compete on a cost competitive basis with foreign ship operators.

a national emergency or contingency. For each participating ship owner, those ships that are part of the SRP program can be requisitioned by the government within the following time periods: 20 percent within 10 days, 30 percent within 30 days and 50 percent within 60 days. This requisition requirement has never been tested under real world conditions. The number of militarily useful commercial merchant ships in the U.S. flag fleet is declining and therefore represents a decline in follow-on surge capability for the U.S. military. [Ref. 2: pp. 13-14]

c. Effective U.S. Controlled Fleet (EUSC)

There are many U.S. merchant ships registered under flags of convenience (i.e., Liberia, Honduras, Panama, etc.). Certain foreign governments allow ship owners to register ships under their national flag. This allows these ship owners to circumvent shipping regulations and policies in the U.S. The ship owners gain financial benefits from doing so. Additionally, these foreign nations allow U.S. ship owners to support U.S. military needs when necessary. EUSC ships can also be requisitioned by Presidential authority if deemed necessary. [Ref. 2: p. 14]

Finally, additional ships can be provided by the non-RRF component of the NDRF. This fleet is made up of older merchant vessels that have been acquired by the

Maritime Administration (MARAD) and placed in lay-up. These ship are mainly used to provide sustainment shipping.

The NDRF is explained in more detail in the next section. This discussion will include a brief history of the NDRF. Following this, the RRF is discussed in detail, addressing ship lay-up, readiness, management, maintenance, outporting and activations.

D. NATIONAL DEFENSE RESERVE FLEET

1. History of the National Defense Reserve Fleet

Shortly after World War II, the NDRF was established under MARAD through Section 11 of the Merchant Ship Sales Act of 1946. The NDRF was established in order to lay-up the large number of merchant vessels that were built during World War II, but were no longer needed for commercial use. At its inception, the NDRF consisted of over 2000 vessels. Over the years the number of ships has fallen. The current fleet size is about 330 vessels.

These ships are maintained at three primary anchorages: James River, VA.; Beaumont, Neches River, TX; and Suisan Bay, CA. Several ships are also based at various locations throughout the United States (outported).

MARAD categorizes ships in the NDRF as either "active or "inactive". The active fleet is those ships maintained for future mobilization during contingencies or national emergencies. The inactive fleet is those ships awaiting

sale or scrapping. The major portion of the active fleet falls into two categories: the Ready Reserve Force (RRF) and the non-RRF.

- The Ready Reserve Force was initiated in 1976. The program was undertaken in response to the dramatic decline in the U.S. flag merchant fleet. Evolution in the U.S. merchant fleet towards fewer, larger ships, containerization and smaller crews has lead to today's smaller U.S. maritime industry. Government and military officials believed that the size of the U.S. merchant fleet was no longer adequate to support U.S. military sealift demands. Additionally, the aging ships in the NDRF can not meet the sealift mobility requirements for the military. The RRF was established to maintain ships in the NDRF at a higher level of readiness in order to meet initial and follow-on surge requirements during any contingency or national emergency.

The RRF is a joint Navy and MARAD program. The Navy provides MARAD guidance concerning RRF composition, outporting requirements and ship types needed. MARAD then executes the Navy guidance. [Ref. 1: p. 26]

- As of December 31, 1990, the non-RRF included 116 vessels. Seventy-one of the breakbulk ships in the non-RRF are Victory ships which were built towards the end of World War II. The other 45 vessels consist of breakbulk,

container, auxiliary crane (TACS), heavy lift, aviation support (TAVB), product tankers, and troopships (see Appendix A for definitions and purpose of each type of vessel).

It is estimated that these ships could be activated in one to six months, depending upon the ship's age and condition. The cost of maintaining ships in a non-RRF status is low relative to other programs. A current GAO study determined that many of the non-RRF ships in the NDRF were no longer adequate to meet current sealift needs, including the older Victory class breakbulk ships. Due to their age and poor condition, these ships could not be realistically activated in a useful time frame for a national emergency or contingency. As older ships are phased out they provide some scrapping income to fund the on-going operations of the active RRF.

DOD and MARAD continue to justify the non-RRF fleet by stressing it is needed to help make up for shortfalls in present military sealift capacity (mainly in the area of sustainment). They are expected to fill in shipping gaps that may develop as shipping losses occur during a future prolonged global war. [Ref. 3: p. 10] There is a general consensus that the older vessels of the non-RRF will be scrapped, but there is no agreement concerning the time frame. [Ref. 3]

2. Maintenance and Operation

a. *Ship Lay-up*

The purpose of laying up, or preserving a ship is to keep the ship's condition from deteriorating too rapidly. When a ship is procured for the non-RRF, or the RRF, it is inspected. All ships must meet American Bureau of Shipping (ABS) and U.S. Coast Guard (USCG) standards and qualify as a "Class I" vessel. Then the ship is thoroughly cleaned. All systems are drained and equipment in the engineering spaces uncovered. The ship compartments are then sealed and vacuumed tested. Dehumidifier equipment is installed with hook ups to the engineering spaces, and other major compartments. Fans in the spaces circulate the dehumidified air. This process is used to help keep the equipment in a laid-up condition and minimize corrosion. Additionally, a cathodic protection system is installed to limit corrosion of the ship's hull. Each ship is inspected by MARAD personnel on a routine basis. [Ref. 4]

b. *RRF Readiness*

Readiness can be defined as the amount of time before a particular ship will be available for loading after leaving a laid-up condition. [Ref. 5: p. 5] Each RRF vessel is assigned a readiness condition (R-status) of 5, 10 and 20 days (R-5, R-10, R-20). The R-status is based upon the logistics support requirements set by DOD. MARAD is

required to maintain each ship in such a condition that it is able to meet the required R-status time period. The R-status is provided by MSC and assigned to each RRF ship.

The R-status, however, does not reflect the actual material condition of the ship. To assess the material condition of each ship, MARAD assigns a C-status. This is a technical ranking and reflects the ship's ability to meet the R-status time requirement. The following is a listing of the C-status categories:

- **C-1-** No mission degrading deficiencies.
- **C-2-** Documented mission degrading deficiencies which can be corrected within the readiness period.
- **C-3-** Deficiencies which cannot be corrected within the assigned readiness period.
- **C-4-** Major deficiencies which prevent the ship from performing its mission and cannot be corrected within the assigned readiness period.
- **C-5-** Ship has scheduled major repairs and is unable to meet its assigned readiness criteria. [Ref. 6: pp. 2-4]

c. RRF Management

Ships in the RRF are maintained and operated by MARAD through contracts with commercial companies. These contractors are known as Ship Managers. The duties of the Ship Manager are extensive. A partial list of major duties is as follows:

- Hire (subject to the Navy's approval) the ship's Master.

- Equip, supply and repair the vessel as necessary.
- When necessary, hire the required crew, both licensed and unlicensed.
- Hire tugboats and pilots and pay the necessary canal and other fees.
- Make the necessary ship voyage and port arrangements. [Ref. 1: pp. 45-46]

d. RRF Maintenance

Once the RRF ship is laid-up, basic maintenance and testing is performed on each ship on a routine basis. This is known as Phase IV maintenance. For ships maintained at the three NDRF sites, maintenance is divided into sections and performed on a monthly basis. For outported ships, maintenance is done once a year (in a 10 to 12 day period). Major repairs are contracted out to a commercial shipyard.[Ref. 4]

RRF maintenance has suffered in recent years. Phase IV maintenance does not provide for the maintenance required to keep RRF ships in the necessary readiness status. Due to budget constraints, a large part the needed repairs to many RRF vessels has been delayed in past years. [Ref. 6] [Ref. 11]

Phase IV maintenance represents a major portion of the costs necessary for RRF upkeep. Table 1 lists the average annual costs by ship class. Additionally, the

required ABS follow-on inspections are approximately $382,000 per year, per ship [Ref. 5: p. 13].

TABLE 1
PHASE IV MAINTENANCE COSTS

Ship Class	*Annual Maintenance Costs ($000)*
Seabee	$400
Lash	240
RO/RO	380
Breakbulk	150
Tanker	150
TACS	300

[Ref. 5]

e. RRF Outporting

Due to the increasing number of RRF ships, the outporting program was initiated in 1986. The three established NDRF sites were unable to activate the increased number of ships so additional locations were selected. Now certain R-5 readiness ships are berthed near prospective military load out locations. This action hopefully reduces shipyard and port congestion during contingency activations. Outporting ships also helps decrease activation and load out times. [Ref. 1: p. 58] Funding for the outporting program comes under the maintenance and operation category of MARAD's RRF program budget. Under the FY 88 to 92 planning guidance, it is projected that the annual costs for RRF ship outporting totals $10 million [Ref. 1: p. 64]. The exact individual operating costs for each ship will vary, depending upon the location and type of ship. Under the

outporting budget plan the main items are for service contracts and supply materials. [Ref. 8]

f. RRF Activations

All, or a large part, of the RRF will be activated during any long term contingency. Most of the burden will be placed on MARAD, Ship Managers and shipyards to activate these ships in a timely manner. In order to prepare for activation, MARAD activates a chosen number of RRF ships each year. Each activation involves a single ship. During an actual contingency, several ships under the control of each region will be activated in a short time period.

There are two types of activations: no-notice and service activations. During no-notice activations, ships are activated with no prior notice. This activation best simulates the actual RRF ship mobilization required during a national emergency or contingency.

Conversely, service activations are conducted with prior notice. These are routinely performed in conjunction with an exercise. Military users identify a particular ship and the ship is then activated. Service activations, in general, are less expensive than no notice activations because the prior planning avoids excessive labor premiums (refer to Table 3). [Ref. 5: p. 5]

The goal of the Navy and MARAD has been to activate each ship once every five years. This coincides with the

five year dry-docking required for ABS re-certification [Ref. 5: p. 1]. Due to budget constraints and reduced funding, actual activations have been limited and fall short of this goal. The activation process consists of the following:

- Ship breakout from the lay-up site or outported location.
- Inspection and repair.
- Crewing.
- 24 hour sea trial (unless the activation is for a particular mission).
- Post repairs, including dry-docking if necessary.
- Deactivation and lay-up.

In order for a ship to meet its readiness requirements, the ship must be in the proper material condition. During activations, all identified problems are repaired prior to the ship deactivation and lay-up. Thus, the material condition of the ship is greatly improved. This helps to ensure that the ship can meet its R-status activation requirement. [Ref. 5] [Ref. 6] [Ref. 9]

One might make the assumption that if one or two ships are successfully activated, then other ships of the same type can also be activated under the same time requirements. This is not true. Past activations have limited value in predicting present and future RRF readiness. A disproportionate number of ships activated in

the past have recently been included in the RRF. Therefore, they are in better material condition than the average RRF ship. Almost all activations have been performed on ships with less than four years in the RRF [Ref. 5: p. 7]. Since it is likely that a significant number of RRF ships will be required simultaneously, a greater cross-section of RRF ships should be activated to better measure readiness [Ref. 5: pp. 6-7]. As of 1990, approximately 75 percent of the RRF had never been activated. This has led many individuals to question the RRF's actual readiness [Ref. 7: p. 14].

Activation is the only way to test an RRF ship operationally. The routine Phase IV maintenance and other inspections do not test the ship's systems under operating conditions. A large part of the problem for RRF ships is that systems are not actually tested during the lay-up and most major repair items found during routine maintenance and inspections are delayed until some future time. The lack of adequate system maintenance and testing during lay-up led to most of the problems for the RRF ships during the Operation Desert Shield/Storm activations. [Ref. 4] [Ref. 6] [Ref. 11]

In dollar terms, it costs approximately $1.5 million per ship, per activation. This figure varies depending upon the ship type (diesel, steam, gas turbine), ship age, time in the RRF and material condition. Table 2 gives a maximum and minimum value for each ship type in the

RRF. The $ 1.5 million comes from averaging the maximum and minimum for the C-3 and C-4 ships [Ref. 5: p. 11]. This is the estimate often used by MARAD.

The Center for Naval Analysis (CNA) developed the following conclusions concerning RRF activation costs:

- In general, older ships tend to be more expensive to activate than newer ones.
- Steamships tend to be more expensive to activate than diesel ships.
- Ships that have received more maintenance during lay-up periods are less expensive to activate than those ships which have received less maintenance.
- The most significant variable affecting activation costs is the amount of time the ship has been in lay-up, especially if the ship has not been activated in recent years. On average, each additional year of lay-up adds approximately $200,000 in shipyard repairs during the next activation. The analysis demonstrates that shipyard repair costs increase greatly as a function of time in lay-up, though there are some limitations to the regression analysis conducted. [Ref. 5: p. 13, App G]

CNA also lists the average costs for activations by ship type, based on FY 1985 to FY 1987 activations data for 18 ships in the RRF. The average costs for the nine no-notice activations was $915,000; it was $654,000 for the

nine service activations. The problem with these cost estimates is that they exclude certain shipyard expenses, such as labor, dry-docking and materials used during the activation/deactivation process. Additionally, these activations were mainly of the newer RO/ROs. Activation of an older ship will be more expensive. [Ref. 5: p. 12] Tables 2 through 4 give historical cost data from this CNA report.

TABLE 2

ACTIVATION COST RANGES FOR RRF SHIPS ($000)

Ship Type	*Minimum*	*Maximum*
Cape "D" RO/RO	750	1,000
Seabee	800	1,200
Lash	800	1,100
TACS	350	600
TAVB	350	700
Potomac	625	1,000
C-3s*	1,000	2,000
C-4s*	1,000	2,000
Vehicle Carriers	1,100	2,000
Patriot State	300	500

[Ref. 5]

*Average numbers used for the $1.5 million cost per activation.

As an interesting note, the cost of activation and deactivation for RRF ships used during Operation Desert Shield/Storm should be higher than normal because of longer ship steaming and operating times and the increased need for repairs prior to deactivation and lay-up. Currently, this is the case with ships that are going through the deactivation process for lay-up. Conversely, these ships

will be in much better material condition in the coming years. This will enhance present and future RRF capability.

TABLE 3

COMPONENTS OF ACTIVATION COSTS

Component	*Man-days*	*No-notice*	*Service*
Activation	1,200	$468,000	$403,200
Repairs	200	80,064	67,200
Activation casualties	366	183,136	153,720
Emergency services		50,000	25,000
Stores supplies		100,000	50,000
Deactivation	800	268,800	268,800
Post dry-dock		250,000	0
Post USCG & ABS inspection		100,000	10,000
Totals		$1,500,000	$977,920

[Ref. 5]

TABLE 4

HISTORICAL GA EXPENSES FOR ACTIVATIONS

Category	*Percent of Total Act. Costs*
Wages of crew & personnel	10.9
Stores and supplies	6.3
Bunker fuel	4.7
Shipyard repairs	60
Wharfage & port expenses	1.2
General agent fees	7.3
Other expenses	10

[Ref. 5]

E. SUMMARY

The RRF is one component in the strategic sealift structure. Its main purpose is to provide follow-on surge shipping during a national emergency or contingency. All facets of RRF maintenance and operations were incorporated

to help maintain these ships in the proper readiness condition. Maintaining the RRF ships in the proper readiness condition is of the utmost importance to help insure that these ships will meet the required activation time schedule when needed. Past experience has demonstrated that RRF maintenance and upkeep is lacking. This has strong implications for the RRF's ability to meet strategic sealift requirements in the future.

III. THE RRF IN OPERATION DESERT SHIELD/STORM

A. BACKGROUND

The unique circumstances of Operation Desert Shield/Storm made up for some of the shortfalls in the U.S. strategic sealift program. International support and the formation of the coalition helped to ensure that foreign shipping was available to make up for shortfalls in the available sealift assets. Host nation support (Saudi Arabia) was extensive. They provided large amounts of fuel and supplies which otherwise would have been shipped to the area. This reduced the sealift requirements. The ports in the area were modern and well equipped, providing easy access for all types of ships and easy discharge of equipment and supplies. The initial months, with the Iraqi forces taking a defensive stance, somewhat reduced the urgency of the military build-up. Even so, the overall delivery of combat and support forces lagged the in-theater commanders' expectations during this period. [Ref. 10:p. 1]

This chapter presents a discussion on RRF performance in Operation Desert Shield/Storm. The emphasis of this discussion is to understand current RRF capabilities and limitations. The first section presents an overview of RRF activations during the contingency. The second section discusses the performance of the RRF during these

activations. Lastly, the conclusions that can be drawn from RRF performance are presented. This section stresses major problems that were encountered during these activations and their main causes.

B. OPERATION DESERT SHIELD/STORM RRF ACTIVATIONS

1. Overview

The deployment of military equipment, supplies and personnel in Operation Desert Shield/Storm was divided into two phases. Phase I, which began on August 7 1990 (C-day) and continued until November 15, 1990 (C+100). Phase II began on 4 December 1990 and continued until 5 February 1991. On August 9 1990, one week after Iraq's invasion of Kuwait, the decision was made to use the RRF to support the surge deployment of U.S. armed forces. After the Secretary of the Navy's authorization on 10 August, MARAD activated 17 RO/ROs from the RRF. Additional activations soon followed. By 31 August, a total of 41 RRF ships had been activated. Of these 41 ships, five (12 percent) were on time, 17 (41 percent) were one to five days late, six (15 percent) were six to ten days late, and four (10 percent) were 10 to 20 days late. The remaining nine ships were still completing activation. The average time to activate RRF ships in breakout yards was nine days. [Ref. 7: p. 16]

By the end of Phase I, a total of 44 RRF ships had been activated. This included 17 RO/ROs, three barge carriers and 24 breakbulk ships. Overall, only 12 (27 percent) were on time and 20 (45 percent) were activated more than five days later than their R-status. [Ref. 12: p. 7] [Ref. 11: p. 6-4]

During Phase II, an additional 27 ships were activated bringing the total to 71 ships. At this point, 20 ships (28 percent) were on time, 41 ships (58 percent) were late, seven (10 percent) were returned, two ships (3 percent) were returned and redelivered, and one ship (one percent) was canceled. [Ref. 7: p. 16]

2. Performance

Operation Desert Shield/Storm was the first large scale RRF activation. Thus, it provided a good measure of the RRF's capabilities, particularly concerning maintenance, operations and manning. Table 5 provides an overall profile of the C-status for the 71 ships that were activated. Additionally, Table 6 gives a detailed RRF activation summary for the 71 ships based on ship R-status.[2]

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[2]A total of 78 ships were activated in conjunction with Operation Desert Shield/Storm. Some ships were used for combat logistics support, others were activated and then deactivated, and two breakbulk ships were activated and maintained in an ROS condition until deactivated. The 71 ships listed in the above tables were used in direct support of Operation Desert Shield/Storm. [Ref. 11: pp. 6-1,3]

TABLE 5
C-STATUS

Type of Ship	*C-1*	*C-2*	*C-3*	*C-4*	*C-5*	*Total*
Breakbulk	8	26	0	0	7	41
TACS	0	2	0	0	1	3
Heavy Lift	1	5	0	0	1	7
RO/RO	0	9	3	2	3	17
Tanker	1	2	0	0	0	3
Total	10	44	3	2	12	71

[Ref. 11: pp. 6-3,5]

TABLE 6
R-STATUS

Time Period	*R-5*	*R-10*	*R-20*	*Total*
Early or on time	11	5	2	18
1-5 days late	16	3	0	19
6-20 days late	19	2	0	21
>20 days late	9	4	0	13
Total	55	14	2	71

[Ref. 11: pp. 6-4,5]

Table 5 shows that 78 percent (54 of 71) of the ships activated were in either C-1 or C-2 status. However, Table 6 shows that only 25 percent (18 of 71) of all ships were early or on time. Specifically, 51 percent of the R-5 ships were greater than five days late, and 43 percent of the R-10 ships were greater than five days late. Thus, there appears to be no direct correlation between the C-status and R-status for RRF ships.

At the time of Operation Desert Shield/Storm, 69 percent of the ships in the RRF were in an R-5 status. This resulted from the Navy's previous policy of assigning newly acquired RRF ships to the R-5 status. This policy has been

discontinued. With the current RRF budget levels, MARAD can only support 40 R-5 ships. [Ref. 11: p. 6-6,7]

During the operation, more ships were needed than activated from the RRF. In total, 212 ships were chartered by MSC for use during the conflict. Of these, 180 ships were foreign and 32 U.S. owned. [Ref. 3: p. 16] To rely on such a large number of foreign ships to support U.S. armed forces in future years can be dangerous. They may not be available in a different situation.

One must question why the remaining ships in the RRF were not activated. The most plausible answers are that they could not be made ready in time and their military utility was questionable [Ref. 10: p. 34]. To maintain these ships and yet not use them when needed is a waste of precious money.

Additionally, there were no U.S. flag merchant ships requisitioned under the SRP program. Because these ships operate in U.S. foreign trade routes, their requisition posed a problem. If these ships were requisitioned, they would be diverted from their commercial business during the contingency. The trade provided by these ships would likely be filled by foreign shipping. This could have created strong economic and political backlash.

3. Conclusions from Performance Results

a. *Maintenance and Upkeep*

The main reason for the poor results with RRF activations is maintenance and upkeep. George G. Sharpe, Inc., conducted a study of the first 45 ships activated from the RRF during Operation Desert Shield/Storm. The study concluded that the poor material condition of the RRF was the primary cause for the delay in ship activations. This has been further reinforced by more recent studies. The Operation Desert Shield/Storm experience with RRF activations shows that the RRF must have more realistic goals concerning material condition and readiness in order to better reflect current capabilities. [Ref. 7] [Ref. 6] [Ref. 11]

Over the past several years, RRF funding shortfalls have limited maintenance and upkeep. To ensure that RRF ships are maintained in the proper condition for a future contingency, regular activations must be conducted. Post analysis of RRF ship activations in Operation Desert Shield/Storm demonstrated that those vessels which were previously activated were better able to meet their R-status date than those that had not been activated. For example, for the 17 RO/ROs activated in Phase I, those that had been previously activated were an average 2.4 days late. Those ships not previously activated were an average 13.6 days

late. [Ref. 11: p. 6-6] Without a greater improvement in maintenance and readiness, most RRF ships cannot be activated within the five day requirement.

Outporting R-5 ships is also important. Under ideal conditions, a ship that is moored at one of the three NDRF sites will require one day to breakout from the mooring and tow to the shipyard. Then it will require a minimum of 24 hours to conduct sea trials. This leaves only three days in the shipyard to activate the ship. If other ships are also being activated at the same shipyard(s), there will be further delays. During Operation Desert Shield/Storm, 79 percent (11 of 14) R-5 ships that were activated from NDRF sites exceeded the 5-day limit by an average of 10.1 days. [Ref. 11: pp. 6-7,8]

b. Ship Managers

There have been numerous problems with the Ship Managers. Prior to 1986, Ship Managers worked on a reimbursable basis for all costs (General Agency agreements). After that, low bid Ship Manager contracts were established. In these contracts the Ship Managers must bid for general (overhead) contracts. Only repairs are reimbursable. This has caused problems. Ship Managers will cut costs wherever possible. For example, there are no full time port engineers to help maintain the RRF ships in their proper material status. Overall, this has caused activation

delays because often there was not enough manpower and support from the Ship Managers to help activate the ship(s). These delays were exacerbated during Operation Desert Shield/Storm since several of the Ship Managers were not prepared to activate so many ships in such a short period of time. [Ref. 4] [Ref. 6] [Ref. 11]

c. *Ship Manning*

The 78 RRF ships activated during Operation Desert Shield/Storm have an estimated 2500 licensed and unlicensed billets. In general, manning problems did not cause delays during the activations. However, there were two skill groups in short supply: senior experienced engineers and qualified radio officers. [Ref. 11: p. 6-11] The manning problem had been of particular concern to MARAD prior to Operation Desert Shield/Storm. Of particular interest for this thesis are two possible solutions being examined by MARAD and the Navy. They are stated briefly here:

(1) Maintaining operating crews on ROS ships and retention crews on R-5 ships. Presently, the eight Fast Sealift Ships are maintained in an ROS status and have small operating crews on board to help maintain the ships in good operating condition. There are current plans to place several of the RO/RO ships in the RRF into an ROS status to maintain these ships in a higher readiness level.

The problem for many of the RRF ships is that the R-5 status does not allow sufficient time for manning and training a crew unfamiliar with the engineering plant. More importantly, it does not allow time for senior licensed engineering personnel (Chief Engineer, First Assistant Engineer) to become familiar with the details of the engineering plant in order to ensure the ship operates smoothly. Placing retention crews on several R-5 ships could alleviate this problem by providing a source of experienced engineers and maintaining the ship in good operating condition. The retention crews could provide services for a single or several "nested" ships at outported locations. [Ref. 11: pp. 6-11,12]

(2) Establish a Civilian Merchant Marine Personnel Reserve. This would provide for the continued training of experienced personnel in the merchant marine industry in order to crew vessels in the RRF in the event of large scale activations. MARAD plans to begin implementing this program in the FY 93 budget cycle. Funding would be provided through RRF appropriations. The following are some important aspects of this Reserve program:

- Each member would commit to a certain length of service.
- They would receive two weeks paid training annually.
- Training would be conducted on RRF ships during regular activations and sea trials.

This type of training program would help ensure that properly trained and experienced personnel are available to meet large RRF activation demands in the future. [Ref. 11: p. 6-13]

C. SUMMARY

Many problems were encountered during the RRF activations for Operation Desert Shield/Storm. The major reasons for the delays during these activations are summarized as follows:

- Poor material condition of the propulsion and auxiliary machinery.
- Difficulty in getting spare parts, especially for foreign built ships.
- Difficulty in obtaining properly trained crews to operate the older steam propulsion plants in the RRF.
- Poor Ship Manager performance.
- No outporting of many R-5 ships.

Conversely, the poor material condition of RRF ships, limited shipyard capacity, limited available manning and lack of sufficient U.S. flag merchant ships were the major reasons the U.S. relied so heavily on foreign flag ship charters in Operation Desert Shield/Storm. Due to the unique circumstances of this contingency, including the international support, an adequate supply of foreign ships was available for military charter. It would not be prudent

to assume that so many foreign ships would be available for a future contingency under different circumstances.

It takes time and money to properly maintain and activate RRF ships. With the 'budget crisis' in recent years, the funding necessary for RRF ship maintenance has not been available. As newer ships are acquired for the RRF to meet the proposed goal of 142 ships by 1994 it will become even harder to maintain ships in the proper material and operational condition. Therefore, future RRF policy must balance new ship acquisitions against maintaining the existing RRF ships in the proper readiness condition.

IV CURRENT SEALIFT ENHANCEMENT INITIATIVES

A. BACKGROUND

The need to make up for the shortfalls in U.S. military sealift capability has been an issue for many years. The rapidly dwindling U.S. flag fleet is the major source of the problem. Efforts over the years to stem this decrease have failed. The U.S. flag fleet is dying because it is not cost competitive with the merchant fleets from other countries.

In most countries, merchant shipping is heavily subsidized. In many cases the entire merchant fleet is government owned and operated (national fleet). Government subsidies for the U.S. merchant marine industry have been all but eliminated within the past 15 years. This contributes to the decline in the U.S. maritime industry (see Appendix B for further discussion on U.S. maritime subsidies). Strict safety regulations and high wages for merchant industry workers greatly increase ship construction and operation costs in the U.S.

The structure of the current sealift force has been largely established by circumstances in the U.S. Maritime industry. As uneconomical commercial ships are phased out, MARAD often acquires and places them into the RRF. Over the years, there has been a growing reliance on government owned shipping to make up for shortfalls in sealift requirements.

The trend is obvious: during the Korean War, U.S. government owned shipping carried 15 percent of the military cargo; during the Vietnam War, it carried 34 percent; in Operation Desert Shield/Storm, U.S. flag vessels carried 63 percent of the total cargo, with 44 percent carried by government owned vessels and 19 percent by commercial U.S. flag vessels. The most startling fact is that during Operation Desert Shield/Storm the U.S. relied on foreign shipping for nearly two-thirds of the sustainment cargo. This trend will only worsen in future years as the size of the U.S. flag fleet continues to diminish. [Ref. 7: p. 17] [Ref. 10]

The shrinking U.S. merchant industry has also created a more dramatic problem: a decline in the size and change in the composition of the merchant marine seafaring work force. In 1981, there were 51,000 seafaring personnel; in 1986 this number was down to 30,000; in 1992 it is estimated between 21,000 and 22,000. [Ref. 14: p. 9] Due to the limited number of jobs available for entry level individuals, the median age in the industry has increased to approximately 55 years. [Ref. 14: p. 11] [Ref. 13: p. 55]

With the increasing size of the RRF, and the decreasing number of U.S. flag vessels the manning problem is going to deteriorate. A key ratio often used by industry experts is the number of operating commercial ships necessary to man an RRF ship. As the RRF ships get older and the commercial

ships become larger and more automated, this ratio will increase. It is currently estimated at 3.5:1. In other words, 3.5 operating commercial ships are necessary to provide enough manpower to effectively crew one RRF vessel. By the mid-1990s this ratio is expected to reach 7:1. [Ref. 13: p. 14]

To successfully overcome these obstacles, an RRF program must support the following areas:

- Provide the ships necessary to support the military's logistics requirements.

- Maintain those ships in sufficient readiness so that they can be quickly activated and reliably operate during a national emergency or contingency.

- Provide the experienced manpower necessary to operate the ships.

- Maintain some minimum level of shipyard capability so that the required RRF ships can be activated without undo shipyard capacity delays.

According to the lessons learned from Operation Desert Shield/Storm, there were many problems in each of these areas. If the past predicts the future, these problems will get worse if action is not taken. This chapter reviews some initiatives directed toward these problems.

B. STRATEGIC SEALIFT IMPLEMENTATION PLAN

In the beginning of FY 1991, Congress directed the Joint Chiefs of Staff to conduct the Defense Mobility Requirements

Study (MRS). This study estimated the requirements for delivering military unit equipment, including surge and follow-on surge. The study found that there was an urgent need for surge shipping. The MRS concluded that additional RO/RO vessels were needed to make up for this shortfall. The FY 1991 National Defense Authorization Act directed the Secretary of the Navy to provide an implementation plan for the FY 90/91 funds authorized and appropriated for sealift. The Department of Defense Appropriations Act for FY 1991 directed the Navy to provide an acquisition plan for these new RO/RO ships. Additionally, the Navy was tasked to work with MARAD to consider acquiring commercially viable sealift ships to meet follow-on surge requirements. [Ref. 17: p. 2]

In February, 1991, the CNO directed the Naval Sea Systems Command (NAVSEA) to begin studying the feasibility of different design concepts for military RO/RO ships. On August 30, the Defense Acquisition Board (DAB) conducted a Milestone 0 review of the Strategic Sealift program. The DAB authorized the Navy to proceed with Phase 0 studies for the initial RO/RO ship designs. The Navy also analyzed different alternatives for acquiring the necessary ships. These alternatives were presented in the Strategic Sealift Implementation Plan. This initial analysis was forwarded to Congress on 4 October, 1991.

NAVSEA then awarded initial design contracts. Nine shipyards submitted designs for a large (950 feet) 24 knot RO/RO and a medium (700 feet) 24 knot RO/RO. The best design concepts from each shipyard were combined to develop the engineering features of each ship. As a result, a large (950 feet) RO/RO has been designed to meet the military requirements set forth in the MRS.

The medium (700 feet) RO/RO design has since developed into a commercial ship possessing military utility. MARAD oversees this development in conjunction with commercial ship operators. Industry experts have reviewed the initial ship designs and expressed some interest. The general characteristics of this commercially viable ship were presented to the Navy in a report dated 14 February 1992.

On 18 June 1992, the Joint Requirements Oversight Council (JROC) approved the key characteristics of the large 24 knot RO/RO (LMSR). However, the JROC deferred a decision concerning the characteristics for a 20 knot commercially viable RO/RO (COM-20). The Navy has since tasked MARAD to further study the COM-20 ship design in conjunction with maritime industry experts. [Ref. 17: p.3]

Currently, the Navy is in the engineering design phase for the 24 knot LMSR. The COM-20 vessel is still being considered for a build and charter concept. The MRS provided a notional acquisition schedule to acquire nine 24

knot LMSRs (300,000 square feet usable capacity) to meet the 2 million square feet prepositioning requirement by 1997. The MRS also provided a notional acquisition schedule for eleven 24 knot LMSRs (380,000 square feet usable capacity) This would meet the 3 million surge sealift requirements. The eleven new LMSRs will supplement the eight Fast Sealift Ships in the existing sealift inventory. [Ref. 17: p. 12]

This thesis is particularly concerned with ships for follow-on surge. There are presently three alternatives being considered:

- Based on the initial shipyard designs, build a commercially viable 20 knot ship (COM-20) with a 200,000 to 300,000 square foot capacity. These ships would be acquired for a build and charter program. Based on the follow-on surge requirements from the MRS, this will require 11-15 newly constructed ships, depending upon the final approved design. Converting existing commercial RO/ROs is an option also under consideration for the build and charter program. The Strategic Sealift Implementation Plan refers to this program as the active RRF alternative. [Ref. 17: p. 14]

- Acquire existing commercial RO/RO vessels, convert them and then place them in the RRF. The MRS placing these ships in an ROS status. An estimated 18 RO/ROs must be purchased under this alternative to meet the follow-on

surge requirements set forth in the MRS. This is referred to as the inactive RRF alternative. [Ref. 17: p. 14]

- The final alternative designs National Defense Features into new construction RO/ROs for commercial use. Under this alternative, the U.S. government would pay for military enhancements (National Defense Features) in new construction vessels, or retrofit existing RO/ROs in order to increase their military utility. In addition, the government would reimburse the ship owner/operator for additional operating costs associated with the NDFs, such as increased fuel or maintenance costs. This would be similar to both the Operational Differential Subsidy program, used by the U.S. government to assist U.S. flag vessel operators engaged in foreign trade, and the Construction Differential Subsidy (see Appendix B for further explanation). The number of ships necessary to meet the follow on surge requirements would depend upon the size and age of the RO/RO vessels currently in the U.S. flag fleet and the new construction vessels being considered for this program. Based on current estimates, 15-18 commercial vessels would be required. This is referred to as the NDF alternative.

Each of these alternatives has the potential to provide the required follow-on surge capacity. To analyze each alternative on an equal basis it is necessary to address

specific areas of concern, such as current and future budget requirements, the effect each alternative will have on the commercial maritime industry and the urgency in meeting the follow on surge shortfall. Each alternative includes financial and non-financial considerations.

C. SUMMARY

Current sealift initiatives are addressing the need for more surge shipping capacity. At present three alternatives are being examined for acquiring RO/ROs for follow-on surge shipping. These include the active RRF, inactive RRF and NDF. The best alternative will provide the most cost effective method for acquiring and maintaining sealift assets and also provide much needed support for the U.S. maritime industry.

V FINANCIAL ANALYSIS AND RESULTS

A. BACKGROUND

The present goal for strategic sealift is to satisfy present and future requirements in a cost effective manner. Meeting the needs of sealift within today's financial constraints is not an easy task. The previous chapters discussed three alternatives that address the follow-on surge requirements established in the MRS. These are the inactive RRF, active RRF and NDF alternatives.

When evaluating different investment alternatives it is necessary to have a set of decision rules to determine the preferred alternative. This chapter will discuss two methods of evaluating these alternatives. First an overview of the analysis conducted by N42 in the Strategic Sealift Implementation Plan (SSIP) will be presented.

Secondly, the "uniform annual cost" analysis for the three alternatives will be discussed. This analysis is the emphasis of this thesis. The uniform annual cost analysis is compared with the SSIP analysis. Then, specific assumptions concerning each alternative, such as acquisition costs, useful lives, ship size and maintenance and operations costs will be addressed. The third part of this section discusses the uniform annual cost analysis and the conclusions that can be drawn from the results.

B. STRATEGIC SEALIFT IMPLEMENTATION PLAN FINANCIAL ANALYSIS

As discussed in Chapter IV, the SSIP presented a notional acquisition profile for acquiring sealift ships to meet current and future requirements for surge and follow-on surge shipping. The primary emphasis of the SSIP is to satisfy the delivery requirements for military combat unit equipment (UE) established in the MRS. The SSIP is essentially divided into two parts: the first part addresses the acquisition method for the 24 knot LMSR to meet prepositioning and surge requirements; the second part addresses follow-on surge requirements.

In the SSIP, two alternatives for ship acquisition for follow-on surge were evaluated, the active and inactive RRF. The NDF alternative, although discussed, was not specifically analyzed in the SSIP. This alternative is similar to the active RRF, except the government would supply funding for those commercial ships built or retrofitted with NDF. Under this alternative, the Navy would not own the ship nor receive leasing income.

Next, the SSIP financial analysis for follow-on surge shipping is presented in more detail. This thesis is specifically concerned with the results of this analysis.

1. SSIP Financial Analysis

The SSIP conducted a life cycle cost analysis for each alternative. This analysis centers on the concept of the present value dollar cost per UE delivered within a time frame of C+50 days (within 50 days of the initial deployment date, or C-day). Thus, the calculations are dependent not only on ship costs, but also on ship size (cargo carrying capacity, in square feet) and speed.

This section presents an overview of the SSIP analysis; the analytical process, specific costs involved, calculations and other important factors. The results of the analysis are then discussed.

a. Analytical Process

The first step in this analysis was to determine the costs that would be incurred for each alternative. This involved estimating the initial ship acquisition costs, ship replacement costs (if applicable) and maintenance costs that were incurred during the ship's useful life. Once this was determined, the present value of the estimated costs were calculated at the required discount rate.

The second step was to determine the leasing income that the Navy would gain under the active RRF alternative. The present value of this income was also calculated at the required discount rate.

The net present value (NPV) for each alternative was then determined. This simply entails adding the present values of the costs (cash outflows) to the present value of the leasing income (cash inflows), (Appendix C addresses the NPV method in more detail). After calculating the NPV, the results must be scaled to adjust each alternative to a common unit of measurement. In this analysis, the appropriate unit of measurement was cargo capacity (square feet of unit equipment) that can be delivered over a particular time period. This is dependent upon ship size and speed. Dividing the NPV by the cargo capacity gives the resulting ship life cycle costs ($million/K-square feet).

Specific assumptions made in the SSIP concerning the ship life cycle costs, including useful life, and size and speed for each alternative are discussed in the following section.

(1) Ship Useful Life. Ships that are newly constructed under the active RRF alternative are assumed to have a 40 year life. The SSIP assumes that these ships will be operated in the commercial industry for 20 years and then placed in the RRF in ROS for the remaining 20 years.

Likewise, when an existing commercial ship is acquired for the inactive RRF, the ship's current age is subtracted from the 40 year life to give the remaining useful life of the ship. When this ship reaches the end of

its useful life, a second ship is acquired and the same process is repeated. Specifically, these calculations assume that a ship would be purchased at the 15 year point and then placed in the RRF for 25 years. At the end of 25 years, another commercial ship is purchased for replacement. The replacement ship costs are factored into the calculations. [Ref. 17: p. 11]

(2) Ship Size and Speed. Ship speed and size are two major factors that must be considered in order to compare the active and inactive RRF alternatives on an equal basis. In the initial designs, shipyards and NAVSEA estimated the size of the COM-20 active RRF ship to be approximately 200,000 to 300,000 square feet of cargo carrying capability. [Ref. 17: p. 14] For the calculations presented in the composite graphs (following pages), the size of the inactive RRF and active RRF ships were estimated at 160,000 square feet and 240,000 square feet respectively. [Ref. 17]

The SSIP analysis assumed a ship speed of 18 and 20 knots for the inactive and active RRF respectively. Although ship speed is important, it has no effect on the results of these specific calculations. These ships will be used for follow-on surge cargo. Due to the cargo availability schedule established in the MRS, these ships are not expected to begin cargo delivery until approximately

the C+21 day point. Once the ship is loaded at the C+21 point and arrives at the first destination, the C+50 limit will have been reached. There probably would not be sufficient time for a second trip. Within this restrictive time frame, two knots will make very little difference. [Ref.18]

b. Results

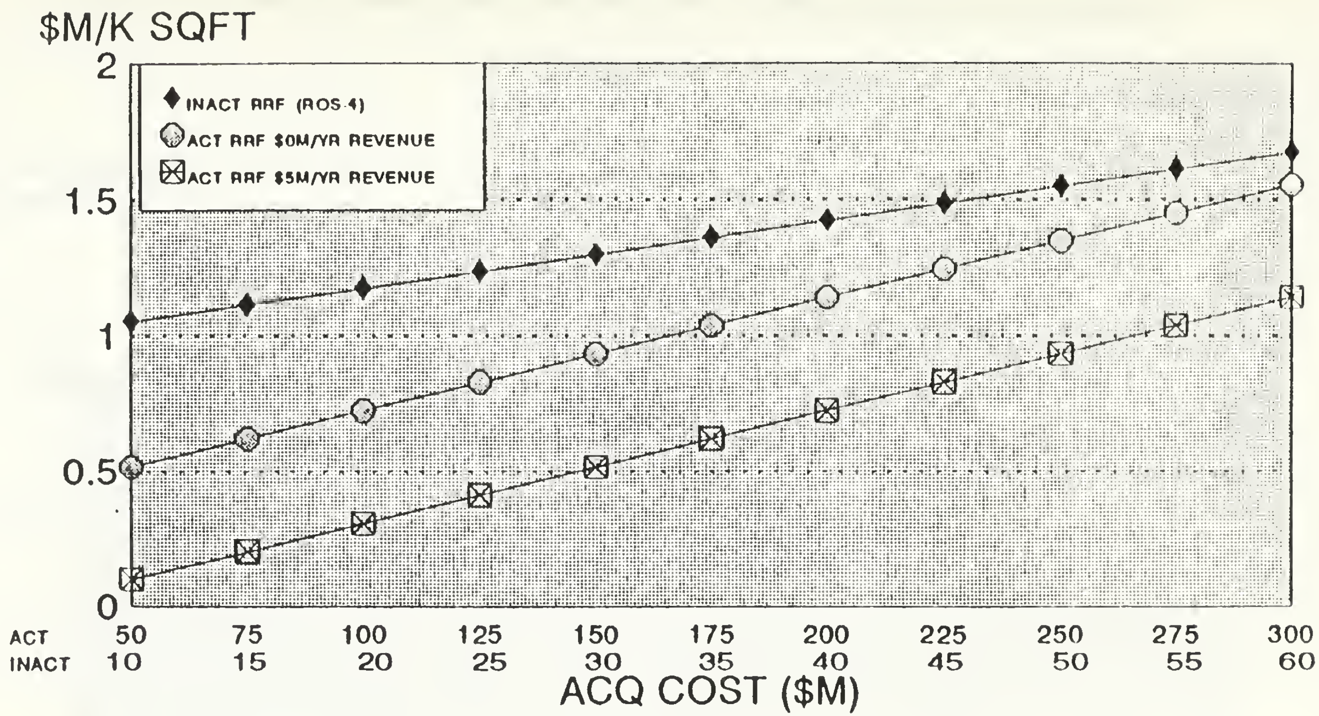
The analysis provides the life cycle cost ($ million) per thousand square feet of UE that can be delivered by the ship in C+50 days [Ref. 17: Appendix D]. This analysis was conducted using a discount rate of zero percent, 4 percent and 10 percent.

Composite graphs for this analysis are presented on the following pages (Figures 1,2 and 3). Each graph shows the variation in life cycle costs given the variation in initial acquisition costs, variations in lease payments for the active RRF option ($0 and $5 million) and the different discount rates. [Ref. 17]

These graphs allow for relative comparison of the two alternatives based upon the main variables presented (acquisition costs and lease rate). For example, using the 4 percent discount rate (Figure 2), assume that an active RRF ship can be constructed at a cost of $200 million. Assuming that the ship can be leased at a $5 million annual rate, then the graph can be used to compare what the

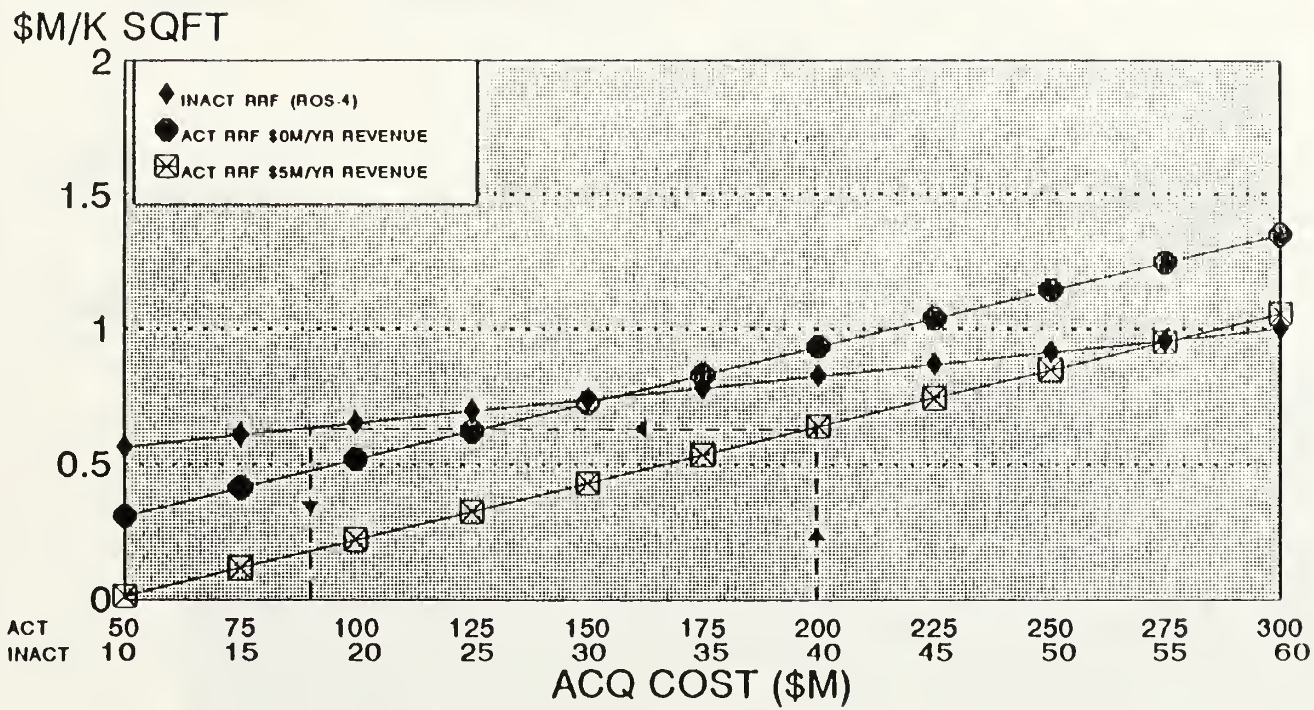
equivalent cost ($M/K Square Feet) of an inactive RRF ship will be to provide the same capability at the same life cycle costs. By choosing the $200 million point on the active RRF ($5M/year revenue) line, move across horizontally to the inactive RRF line and then identify the acquisition cost that equates to the same level of life cycle cost for the inactive RRF. This is approximately $18 million. If a new construction costs are $200 million and an existing commercial ship can be acquired for the inactive RRF at a cost of $18 million or less, then purchasing an existing ship would be the better alternative based on these life cycle cost calculations.

The graphs show that the inactive RRF alternative is less sensitive to acquisition costs than the active RRF alternatives. Additionally, the higher the discount rate, the less sensitive the inactive RRF alternative becomes to acquisition costs. In particular, increases in the discount rate decrease the slope of the inactive RRF line while the slope of the active RRF line ($0 and $5 million leasing income) remains relatively constant. As seen in Table 7, by doubling the acquisition costs for each alternative, the percent change in the life cycle cost for the active RRF decreases as the discount rate increases, while the percent change for the inactive RRF increases as the discount rate increases.



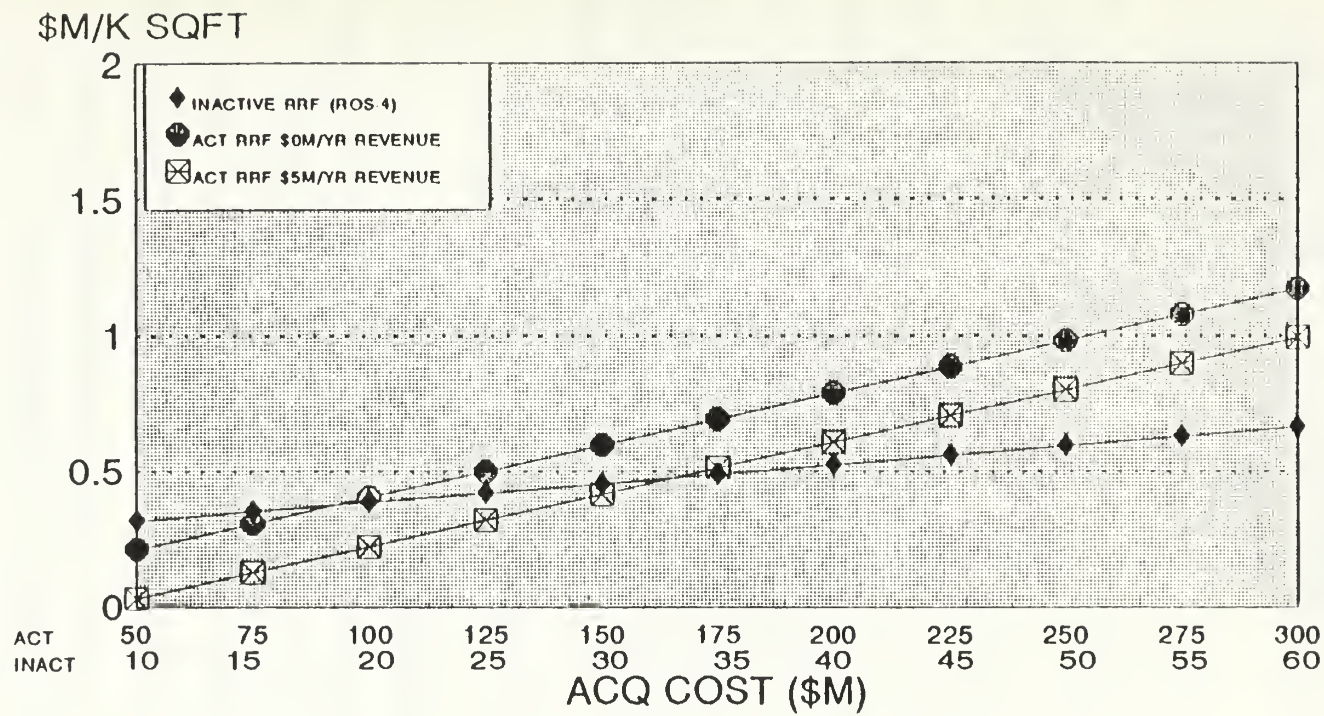
Active RRF (240K SQFT)
Inactive RRF(160K SQFT)

Figure 1. Active vs. Inactive RRF Life Cycle Cost (40 years, 0 percent Discount Rate)



Active RRF(240K SQFT)
Inactive RRF(160K SQFT)

Figure 2. Active vs. Inactive RRF Life Cycle Cost (40 years, 4 percent Discount Rate)



Active RRF (240K SQFT)
Inactive RRF(160K SQFT)

Figure 3. Active vs. Inactive RRF Life Cycle Cost (40 years, 10 percent Discount Rate)

TABLE 7
LIFE CYCLE COSTS AT A 4 AND 10 PERCENT DISCOUNT RATE

	Acqu. Costs ($M)	Life Cycle Costs	
		4%	*10%*
Active RRF	$100	0.25	0.25
($5M lease)	$200	0.7	0.65
	% change	180%	160%
Inactive RRF	$20	0.75	0.4
	$40	0.85	0.55
	% change	13%	37.50%

The results of the study yielded no definite conclusions regarding the preferred alternative. Instead, the study provides a method of comparing alternatives based on the initial acquisition costs of the ship. Identifying the most cost effective alternative warrants further analysis. The following uniform annual cost analysis provides some of the required information.

C. UNIFORM ANNUAL COST ANALYSIS

The uniform annual cost analysis provides an improved method for comparing the alternatives discussed. This approach differs from the SSIP analysis in three ways. First, as the name implies, the uniform annual cost analysis is used to calculate an annual vice overall cost. This allows the costs of ships with different life cycles to be compared on an equal basis. Second, this analysis takes into consideration a larger set of costs incurred under the

alternatives. Specifically, the analysis includes merchant marine reserve personnel training costs and ship scrap values. Third, the analysis is expanded to evaluate the NDF alternative.

The guidelines for the uniform annual cost analysis are drawn from various financial accounting textbooks (see bibliography) and the Department of Defense instruction entitled "Economic Analysis and Program Evaluation for Resource Management" (DODD 7041.3). Instruction DODD 7041.3 provides guidelines for comparing alternative investments with different useful or economic lives.[3] It states:

> Uniform annual cost should be calculated when alternatives have different economic lives. It is obtained by dividing the total present value cost (NPV) by the sum of the present value factors of the years in which an alternative yields benefits [Ref. 20: p.7].

Calculating the uniform annual costs for an investment is essentially the same as determining the annual payments that would be incurred with an annuity. An annuity is a series of payments at equally spaced intervals over a given period of time. [Ref. 23: p.712] The basic formula for determining this annual payment is as follows:

PV of the Future Cash Flows =

Annual Payments x Sum of Discount Factors

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[3]Economic life is defined as the period that an alternative investment yields benefits [Ref. 20: p. 7]. For purposes of this discussion, useful life and economic life have the same meaning.

After calculating the present value of an annuity, the annual payments can be determined by dividing this value by the sum of the discount factors over the life of the annuity. The main idea behind this approach is that an aggregate total cost of an alternative is re-expressed as an annual cost.

In the following section, an overview of the uniform annual cost analysis is presented. This discusses the uniform annual cost calculations and differences between this analysis and the SSIP analysis. Also discussed are the assumptions used in calculating the uniform annual costs.

1. Analysis Overview

When calculating the uniform annual costs for each alternative investment, the NPV of the future cash flows, both inflows and outflows, is determined as discussed in the SSIP analysis. Once determined, the NPV is divided by the sum of the discount factors over the life of the investment. This provides the uniform annual costs. In essence, the uniform annual cost is a measure of the average annual cost of an alternative over its useful life.

Calculating the uniform annual costs represents a different approach than the SSIP analysis for two main reasons. First, this calculation presents costs on an annual basis. This provides a method for comparing each

alternative based on an annual cost vice an overall cost, as in the SSIP.

Secondly, it allows for directly comparing alternatives with different useful lives. For example, the SSIP analysis assumed that a ship constructed under the active RRF alternative would have a useful life of 40 years. A ship acquired from the commercial market for the inactive RRF would have a shorter useful life, estimated at 25 years. To compensate for this shorter useful life, the SSIP analysis incorporates acquisition costs for a second ship from the commercial market at the 25 year point. This extends the useful life of the inactive RRF out to 40 years and beyond. In contrast, by calculating the uniform annual cost, alternatives with different useful lives can be compared on an equal basis. Consequently, the future acquisition costs for the second inactive RRF ship are not required in this analysis.

An important fact to point out is for the uniform annual cost calculations to be valid it is assumed that at the end of a ship's useful life, whether it be 40 or 25 years, another ship of approximately equal value will be purchased. This assumes maintaining an ongoing production cycle.

2. Assumptions

The uniform annual cost calculations for each alternative are based on the acquisition costs, ship useful life, ship size, leasing income (if applicable), and maintenance and operating costs.

In general, the same factors used in the SSIP analysis are used in this analysis, with some additional factors included. First, the estimated costs for training personnel in the proposed merchant marine reserve program are incorporated in this analysis. Due to the RRF manning problems, it is important to include these costs to more accurately estimate the overall costs of each alternative. Second, an estimate for the scrap value of the ship at the end of its useful life is included, in order to incorporate all future income that can be earned for each alternative. Lastly, as stated previously, the NDF alternative is included in this analysis. The same factors apply under the NDF alternative except an operating differential subsidy cost estimate is also included. If this alternative were undertaken in the future, the government would have to pay an operating differential subsidy to the ship operator to offset the added costs of operation due to the NDFs. Therefore, this cost is included to better estimate the total costs to the government for the NDF alternative.

Next, the particular assumptions concerning the values for the factors used in uniform annual costs calculations for each alternative are addressed. The first section will discuss the assumptions concerning the costs and income. This is divided according to the three alternatives: inactive RRF, active RRF and NDF. The second section will present assumptions for ship size and speed. The results of the uniform annual cost analysis are presented at the end of this section. This will include a discussion of major variables and how they effect the results. A uniform annual cost example calculation is provided for each alternative in Appendix C. This provides a detailed step by step procedure for how these calculations were conducted.

a. Inactive RRF

(1) Acquisition Costs. The estimated acquisition costs for current commercial RO/ROs will vary depending upon the ship's size, type (diesel or steam, foreign or domestically built) and age. The acquisition costs include funds used to convert the ship for military use and any additional costs to place the ship in the RRF. Estimates for acquiring and converting current commercial ships are generally in the range of $20 to $40 million. Initially, for purposes of this calculation, it is assumed that the acquisition costs are $40 million. [Ref. 9] [Ref. 17] [Ref. 19]

(2) Ship Useful Life. The estimated overall useful life of a ship is approximately 40 years, at which point the ship becomes obsolete and is scrapped. [Ref. 17] When a ship is initially acquired by MARAD, its useful life for the RRF will be the total time period it is available for use in the RRF. Since older commercial ships are acquired by MARAD for the RRF, it is safe to assume that the ship has reached the end of its economic life. This will normally be anywhere from 15 to 25 years. For this analysis, it is assumed that the commercial ship would be acquired at the 15 year point, after commercial operation. At that point it is converted and placed in the RRF. The conversion is assumed to take one year. Thus the ship is assumed to have a 25 year expected life in the RRF. This is consistent with the assumptions used in the SSIP analysis.

(3) Maintenance. The MRS requires that each of the RO/ROs presently in the RRF, and any future RO/ROs acquired for the RRF, be placed in ROS. These ships are very useful for transporting military cargo. Therefore, they must be available sooner than the other lower priority ships in the RRF. ROS ships will be outported near their anticipated equipment loading sites, have a small crew (8-10 members) on board to maintain the ship and undergo sea trials on an annual basis. The annual cost estimates for maintaining a ship in an ROS status are presented in Table 8. These

estimates are used for the yearly maintenance cash flow. [Ref. 11: p. A-3]

(4) Merchant Marine Reserve Personnel. There will also be costs associated with training reserve personnel to man each inactive ship. MARAD estimates that it will cost approximately $4600 per year to train an individual in the proposed merchant marine reserve program [Ref. 19: p. 34]. Assuming that the required crew size for the ship is 30 members (estimated from current ship crew sizes) and there are 8-10 ROS crew members already on board the ship, an additional 22 crew members (30 less 8) will be required to fully man the ship. These 22 potential crew members will be trained in the reserve program at an annual cost of $101,200 (=22 x $4600). These costs were not factored into the SSIP analysis.

TABLE 8

Reduced Operating Status Annual Costs (Thousands)

Activations (sea trials)	$500.00
Logistics	103.00
Maintenance and Repair	875.00
Miscellaneous	825.00
Outporting	200.00
ROS Operating Crew	1,000.00
Ship Manager Fee	239.00
	Total $3,742.00

[Ref. 11: p. A-3]

(5) Disinvestment (Sale/Scrap). Scrap rates vary widely from year to year depending upon the current market

conditions. There is also a large difference between ship scrap rates in the U.S. and foreign shipyards. Scrap rates (per ton) tend to be lower in the U.S. due to higher shipyard operating costs and restrictive environmental regulations. In a U.S. shipyard, the scrap rate can vary from $50 to $100 per ton, where in a foreign yard they can vary from $70 to $140 per ton [Ref. 3]. For this analysis it is assumed that the ship is scrapped at a price of $50 per ton. This rate is used for conservatism, since the lower scrap rate will least offset the NPV of the overall ship costs. Assuming that the ship has a displacement of 40,000 Long Tons (LT), the scrap value is $2 million (=40,000 LT x $50 per ton). Scrap income was not factored into the SSIP analysis.

b. Active RRF (COM-20)

(1) Acquisition Costs. With the design phase for the COM-20 ship still in progress, there are no firm initial cost estimates for constructing the ship. Even so, based on the initial cost estimates for the 24 knot LMSR (discussed in Chapter IV) the best estimate for the initial acquisition costs of the COM-20 ship would be approximately $200 million [Ref. 9].

The cash outlays for the construction will be based on a four year contract, with the annual payment rate based on the following schedule:

- Year 1- 18%
- Year 2- 33%
- Year 3- 35%
- Year 4- 14% [Ref. 19: p. 7]

(2) Ship Useful Life. After the four year construction period, the ship will be leased to the commercial industry for 15 years. After 15 years it reaches the end of its economic life. At that point, the ship is placed into the RRF where it is maintained in ROS, just as the inactive RRF ship in the previous discussion. During the first 15 years of operation, the Navy will earn the leasing income. When the ship is placed in the RRF, the Navy will incur the same annual costs for maintaining a ship in an ROS condition, including the annual training costs for merchant marine reserve personnel.

The 15 year lease was chosen for two reasons. First it is consistent with the assumption introduced in the previous inactive RRF discussion. Secondly, it is more conservative in comparison to the SSIP analysis assumptions, which estimated that the ship would be leased for 20 years. By assuming the ship is only leased for 15 years, the Navy does not receive leasing income and must pay the required maintenance costs for the extra five years the ship is in the inactive RRF.

(3) Operating Income. It is hard to estimate the actual leasing income. As previously discussed, the SSIP

analysis uses a rate of $0 and $5 million. The $5 million equates to a daily lease rate of approximately $14,000. This is roughly equivalent to the current shipping market bareboat charter rate. [Ref. 22] However, this lease rate would represent a gross cash flow. Expenses incurred by the Navy and MARAD for additional costs associated with the ship leasing, (i.e., administrative costs, inspections, etc.) must be deducted to determine the net cash flow. It is not unlikely that the net cash flow from the ship leasing will be zero.

The main purpose of leasing the ship is not to recover costs or make a profit, as in a commercial lease, but to avoid the yearly costs to maintain the same ship in the RRF. The actual lease rate will be the rate supported by the shipping market at the time. These rates vary widely depending upon the economic and market conditions. For this initial analysis a lease rate of $5 million will be used so the results can easily be compared to the SSIP analysis results. Different lease rates will be analyzed later in the chapter.

(4) Maintenance and Merchant Marine Reserve Personnel. Once the ship is placed into the RRF, it will be maintained in ROS. The same costs incurred in the previous discussion for the inactive RRF apply in this situation,

including the annual cost of training the necessary personnel in the Merchant Marine Reserve.

(5) Disinvestment (Sale/Scrap). The initial designs for the COM-20 ship estimates the ship to be approximately 40,000 LT. Using the scrap rate discussed previously, the ship scrap value will be $2 million at the end of 40 years. [Ref. 17]

c. National Defense Features (NDF)

(1) Acquisition Costs. The underlying factor that will effect the construction costs for a commercial ship with NDFs is the cost differential between constructing an equivalent ship in a U.S. and foreign shipyard. In the SSIP, MARAD estimated that the costs for a commercial ship with NDFs, that was equivalent to the COM-20 ship, was approximately $160 million in a U.S. shipyard. The costs for constructing an equivalent ship (without NDFs) in a foreign shipyard was $56 million (1991 dollars). Thus, the commercial company would pay $56 million, and the U.S. government $104 million ($160 less $56 million), for constructing the ship. [Ref. 17: p. 20] This analysis assumes that the government acquisition costs are $104 million. The four year payment rate presented in the active RRF discussion (18%, 33%, 35% and 14%) is used for this calculation.

(2) Ship Useful Life. As discussed previously, a commercial ship generally operates for 15 to 25 years. For consistency with the previous discussions, this analysis assumes that the ship is operated by a commercial shipping company for 15 years. After 15 years, the ship is turned over to MARAD and placed in the RRF in ROS. The ship is retained in the RRF until it reaches 40 years. At this point it is sold for scrap.

(3) Operating Differential Subsidies. Current Operating Differential Subsidy (ODS) information is published yearly in the MARAD Annual Report. The annual report shows the names of the participating shipping companies, the accrued ODS liabilities for MARAD and the ODS paid to each shipping company over the past years (since 1937). Although ODS payments are not listed on a ship by ship basis, this information can be used to estimate the operating subsidy that would be incurred if the Navy were to subsidize a ship with NDFs. Estimates for the operating subsidy used the current accrued ODS liability, the number of ships receiving ODS and the time period remaining in the ODS contract for each participating shipping company. An average for the four companies is then taken. The results are presented in Table 9.

This is a very rough approximation based on historical data. Actual ODS funding for a particular ship

is based on the size of the ship, the NDFs incorporated in the ship construction and the trade for which the ship is used (i.e., the trade route and the number of voyages per year for that ship).

TABLE 9
ODS ESTIMATION

Company	*ODS Liability*	*# of ships*	*Years Left*[1]	*ODS/ship/year*
American President Lines	$6,923,782	23	6	$50,172
Farrel Lines Inc.	1,022,385	5	4	$51,120
Lykes Brothers Steamship	14,323,618	27	7	$75,786
Waterman Steamship	2,790,797	4	5	$139,540

Average= $79,155

[1] Years remaining in ODS contract.
**Source: MARAD 1990 annual Report.

(4) Maintenance and Merchant Marine Reserve Personnel. After retiring from commercial use, the ship is placed in the RRF in ROS. The same costs apply as previously discussed, including the costs for training reserve personnel.

(5) Disinvestment (Sale/Scrap). At the end of the ship's 40 year useful life, it is scrapped at the same value assumed previously ($2 million).

d. Ship Size and Speed

This analysis uses the same assumptions presented in the SSIP analysis for ship size and speed. Additionally, since a size of 160,000 sq-ft and speed of 18 knots are used for the inactive RRF commercial ship, the same size and

speed assumptions are used for a new construction ship with NDFs.

The size and speed of a ship are important considerations for the active RRF alternative. As stated previously, the initial size estimates for the COM-20 ship is 200,000 to 300,000 square feet of cargo capacity. The larger size and speed for the ship being proposed by the Navy presents a problem. Comparable commercial RO/ROs are slower and smaller. When commercial ships are designed and built, the speed and size of the ship are kept in balance. A ship that is too large and/or too fast can be more expensive to operate than a smaller, slower ship. The proposed COM-20 ship, which will be larger and faster than presently operating commercial RO/ROs, will require a much larger propulsion plant and consequently cost more to operate. Therefore, it is likely that the Navy will have to reduce the annual leasing rate to take this into account. Variations in lease rates will be considered later in the chapter.

3. Results

Table 10 displays the results of this analysis based on the assumed values for the factors, as discussed above. From these results it can be seen that the inactive RRF alternative provides the lowest uniform annual cost per thousand square feet of cargo capacity.

TABLE 10
UNIFORM ANNUAL COSTS/K-Sq-Ft (UAC)

Alternative	*PV Acqu.*	*PV Lease*	*PV ODS*	*PV ROS*	*PV Reserve*	*PV Scrap*	*NPV*	*UAC*
Active RRF	(174.89)	28.57	N/A	(6.1273)	(0.1657)	0.03	(152.58)	(0.0586)
Inactive RRF	(40)	N/A	N/A	(33.6400)	(0.908)	0.18	(74.37)	(0.0457)
NDF	(91)	N/A	(0.4286)	(6.1273)	(0.1657)	0.03	(97.63)	(0.0562)

These results can be compared to the SSIP analysis results. Given a 10 percent discount rate, at an acquisition cost of $200 million, the UAC for an active RRF ship is 0.0586 ($M/K-sq-ft), whereas at an acquisition cost of $40 million an inactive RRF ship has a UAC of 0.0457. Thus, the inactive RRF is the most cost effective alternative. These same conclusions are obtained with the SSIP analysis (given the same acquisition cost estimates). Additionally, from the results of the UAC analysis, it can be seen that the NDF alternative is competitive with the active RRF alternative.

In order to thoroughly examine each alternative and determine the best one, it is necessary to look at the variables presented and discuss how each effects the calculations. The following section presents a sensitivity analysis for the major variables in the calculations. These include acquisition costs, lease rates and discount rates. The results of this sensitivity analysis are presented in Figures 4, 5 and 6.

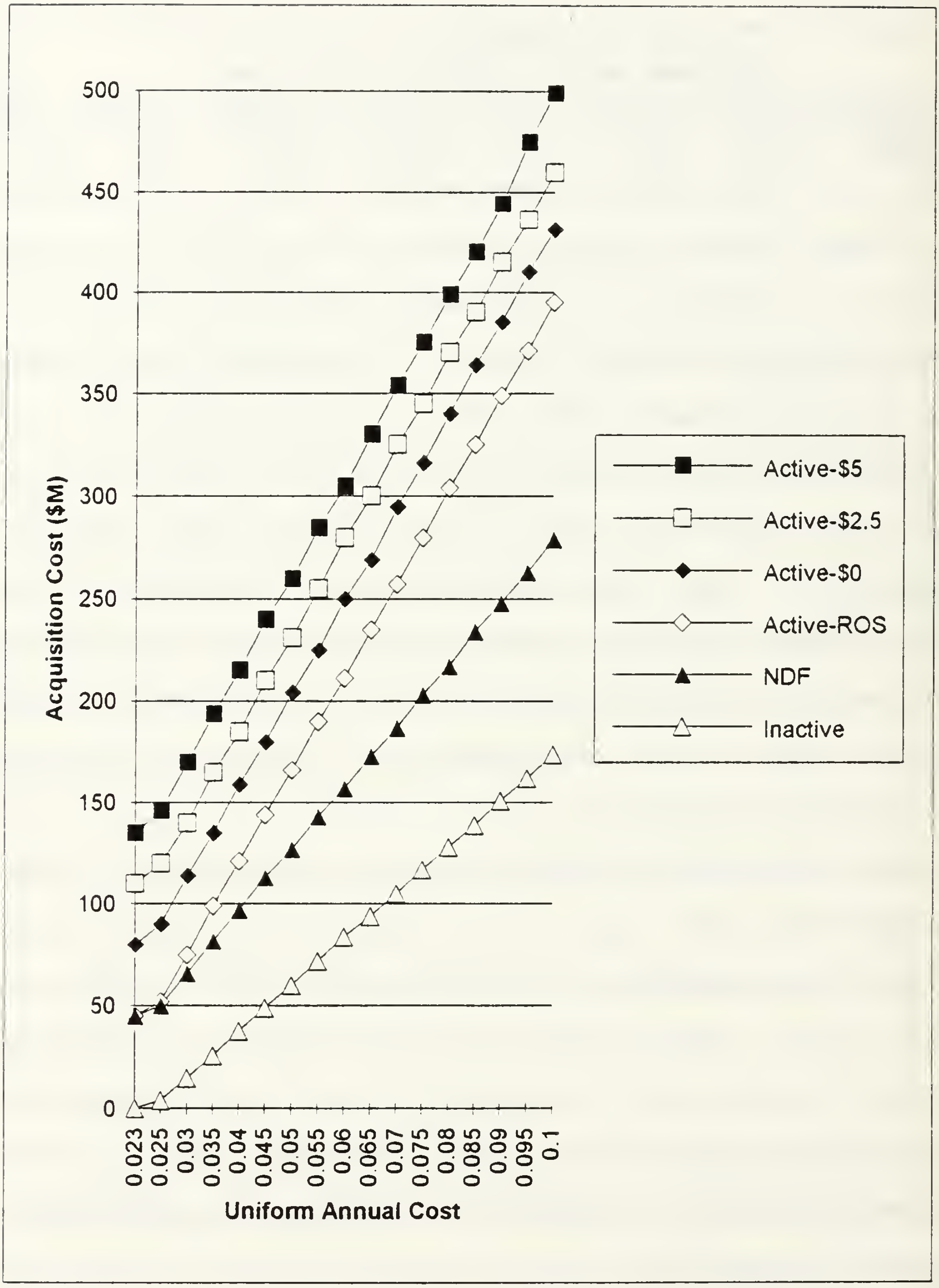

Figure 4. Acquisition Costs vs. Uniform Annual Costs (5% Discount Rate)

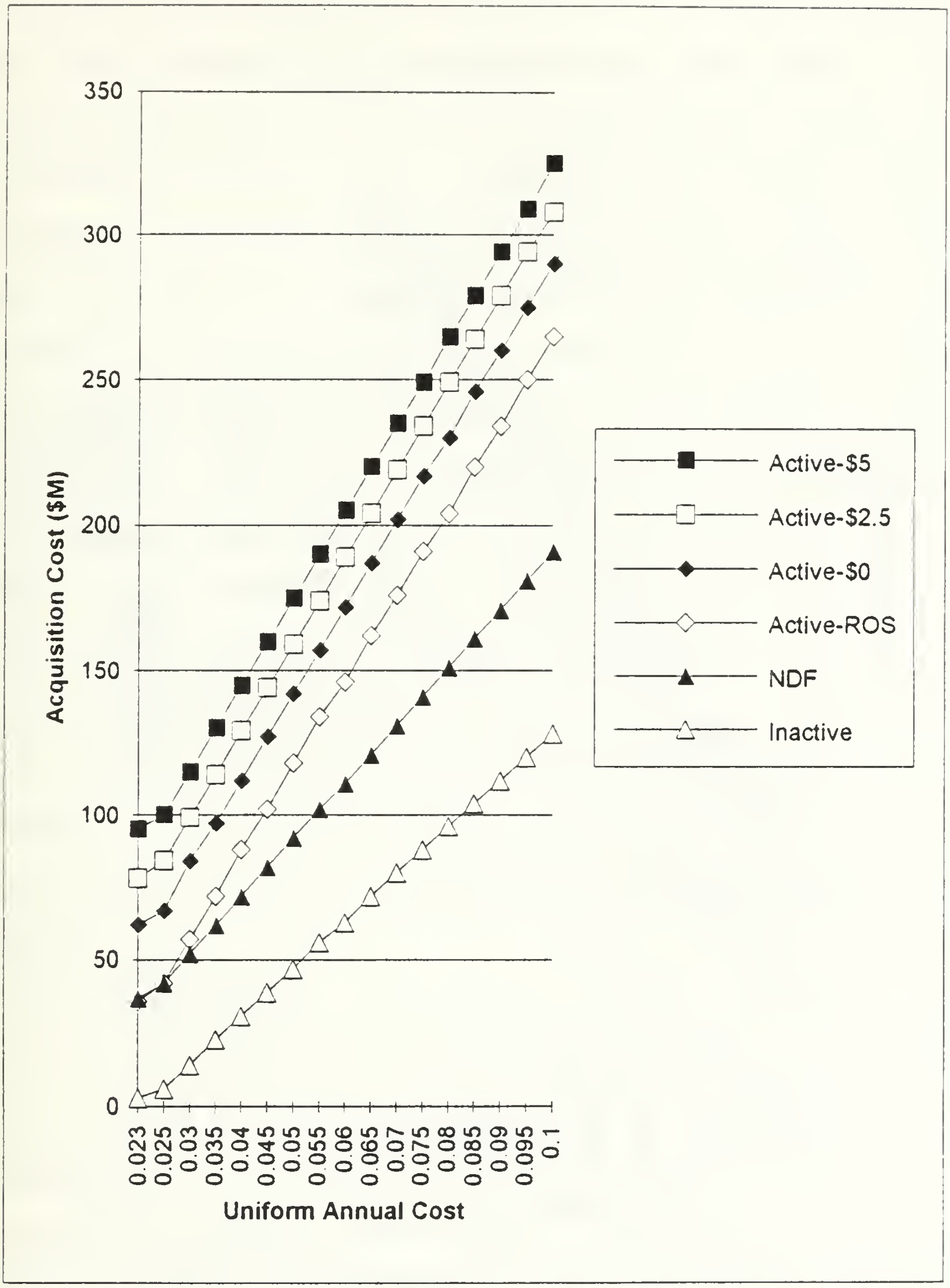

Figure 5. Acquisition Cost vs. Uniform Annual Cost (10% Discount Rate)

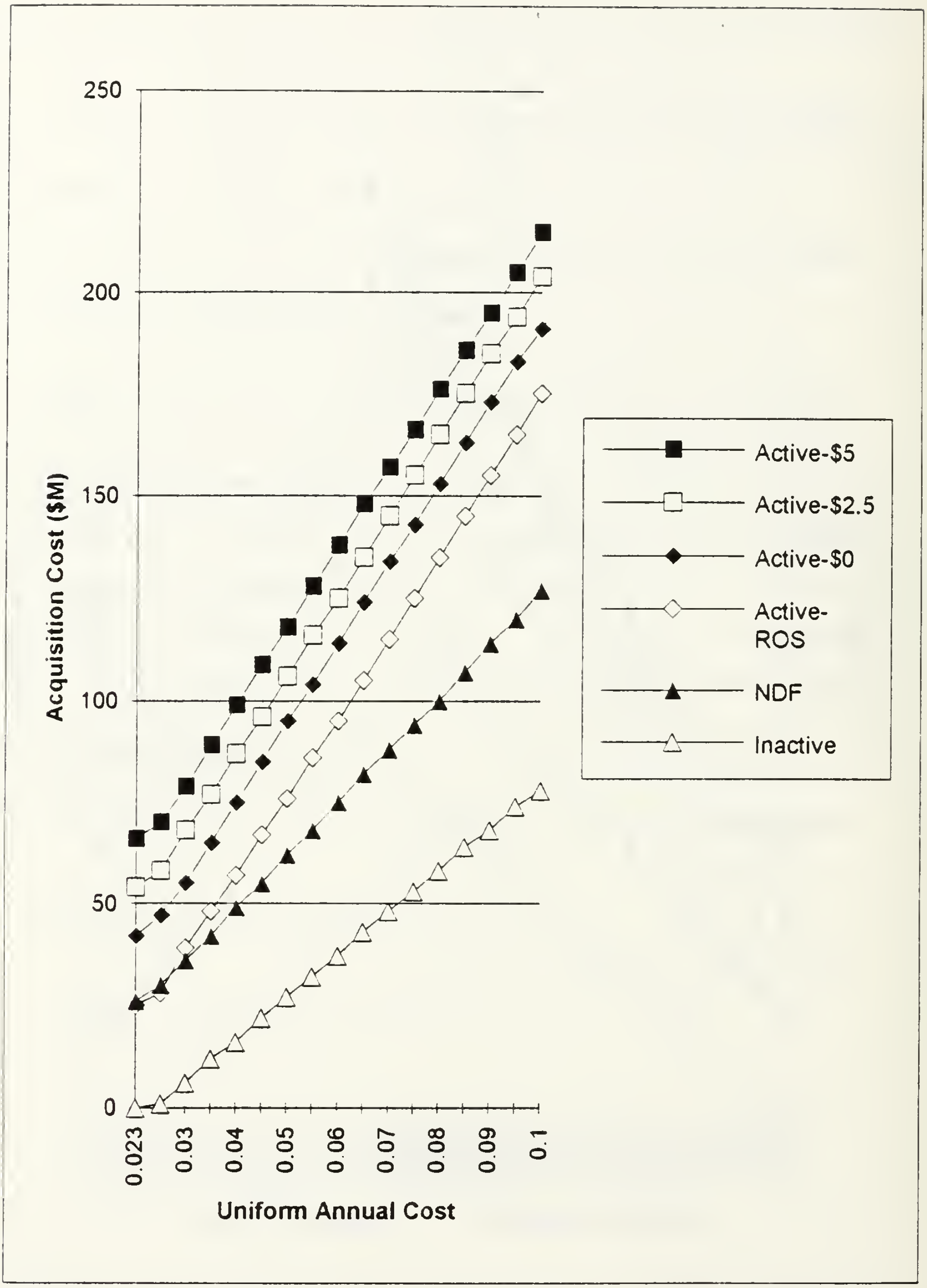

Figure 6. Acquisition Cost vs. Uniform Annual Costs (15% Discount Rate)

For this sensitivity analysis, the ROS maintenance costs were assumed constant, since these costs will not vary greatly from year to year. Reviewing Table 10 shows that the present value of the assumed annual costs for the merchant marine reserve program under each alternative is small compared to the present value of the other variables. The same conclusion can be drawn about the present value of the operating differential subsidy (ODS) under the NDF alternative. Additionally, since the cash inflow from the ship scrap is well into the future, its' present value is small. Due to these facts, all of the above values were held constant during this sensitivity analysis.

a. Acquisition Costs

The acquisition costs are the largest cash outflow and occur in the first years of the investment life cycle. Thus, these cash outflows have a large effect on the final results.

b. Lease Rate

The lease rate used for the analysis of the active RRF alternative has a great effect on the resulting conclusions. To analyze this, a lease rate of $0, $2.5 and $5 million was used. Additionally, to consider a worst case scenario, the uniform annual cost analysis was also conducted for a COM-20 ship that was not leased after

construction. Instead the ship was placed into the RRF in ROS for its 40 year useful life.

The purpose of varying the lease rate is to provide a further method of comparison. When a better estimate of the lease rate for a COM-20 ship can be obtained, the graphs allow for comparing uniform annual costs at that particular lease rate to determine comparable acquisition costs for each alternative.

c. Discount Rate

In the standard NPV analysis, the discount rate reflects the alternative uses for the required capital and the riskiness of the investment. For the commercial company, earning a profit is of the utmost concern. The discount rate is often compared to a "hurdle rate". If an investment can earn a return greater than its hurdle rate, then the company will undertake the project. [Ref. 18: p. 592] However, this concept in many respects does not apply to government investments. Government's goal is to maximize the capabilities of strategic sealift while minimizing the overall costs.

The guidelines for the discount rate to be used in economic analysis is set forth in DODD 7041.3, which states:

> Interest will be treated as a cost which is related to all Government expenditures, regardless of whether there are revenues or income by way of special taxes for a project to be self-sustaining. This policy is based on the premise that no public investment

should be undertaken without explicitly considering the alternative use of the funds which it absorbs or displaces [Ref. 20: p. 6].

The reasoning behind the standard ten percent discount rate is that it reflects forgone private sector investment opportunities (opportunity costs). The discount rate is determined by the preference for current and future money sacrifices that the private sector shows in private investments. Thus, the prescribed discount rate of ten percent represents an estimate of the average rate of return on private investment before corporate taxes and after adjusting for inflation. [Ref. 20: p. 6-7] This definition for investment opportunity costs is only valid if the government funds projects that have an NPV greater than zero. If the budget is set without regard to the NPV for government projects, as it is, return in the private sector is irrelevant for government discount rate decisions.

Additional research has been conducted on this topic. Some analysts recommend using lower discount rates, such as the consumer rate of interest, the Treasury bill rate, or a weighted average of the consumer rate of interest and the pre-tax corporate rate of return. [Ref. 21: pp. 17-18] Still others stress the 'opportunity cost' approach, where the correct discount rate should reflect the opportunity cost of each alternative investment being considered within a set government budget. As the

government budget (especially the military budget) becomes smaller, this opportunity cost discount rate increases because there is less money available to fund these alternative projects. Therefore DOD may want to consider a discount rate other than the standard ten percent.

d. Conclusions From the Results

The graphs for the uniform annual cost analysis are presented in a different format than those in the SSIP analysis. Uniform annual costs are presented on the X-axis and the acquisition costs on the Y axis. This is done to emphasize the fact that when the discount rate increases, the magnitude of the acquisition costs decreases, for a given uniform annual cost.

Some important conclusions can be drawn from the graphs:

- **Acquisition Costs**- the slope of the line for each alternative reflects the sensitivity of the uniform annual costs to the acquisition costs. The slope of the lines for the active RRF and NDF alternatives are higher than the inactive RRF. This implies that the uniform annual costs for the inactive RRF are more sensitive to the acquisition costs than the other two alternatives.

The acquisition costs will have a strong effect on the results of the analysis. Estimated acquisition costs for each alternative were discussed previously. In particular,

estimated costs were $200 million for the active RRF, $104 million for the NDF and $40 million for the inactive RRF. Given these best estimates, the most cost effective alternative is the inactive RRF. It has a lower uniform annual cost. What effect do variations in these acquisition costs have on the final results? To determine this, values 50 percent above and below these estimates are considered. The corresponding uniform annual costs are presented in Table 11 (10 percent discount rate).

TABLE 11

	Acqu. Cost ($5M)	*UAC*
Active RRF	$300	0.092
	$200	0.059
	$100	0.025
NDF	$156	0.082
	$104	0.057
	$52	0.030
Inactive RR	$60	0.058
	$40	0.046
	$20	0.033

From the table it can be seen that at higher acquisition costs the inactive RRF alternative is the most cost effective. At lower acquisition costs, the active RRF and NDF alternatives more cost effective. Therefore, the initial acquisition costs for each alternative will have a strong effect on the outcome of the analysis.

• **Discount Rate-** assuming the best estimated acquisition costs and a $5 million annual lease rate, Table 12 shows how the uniform annual costs change as the discount rate increases. This table demonstrates two important relationships between the uniform annual costs and the discount rate:

TABLE 12

		Uniform Annual Costs		
	Acqu. Costs ($M)	*5%*	*10%*	*15%*
Active RRF ($5M)	$200	0.0365	0.0586	0.0924
NDF	$104	0.0427	0.0567	0.0833
Inactive RRF	$40	0.041	0.0457	0.0625

1. As the discount rate increases (from the 10 percent originally assumed), the inactive RRF alternative becomes even more attractive *relative* to the other two alternatives. Conversely, at a lower discount rate the active RRF becomes the preferred alternative.

2. As the discount rate increases, the uniform annual costs will increase. Recall in the earlier discussion that the uniform annual cost is the same as calculating the annual payment on an annuity. For the same initial investment, the annual payments increase with the interest rate on an annuity. The same situation applies here. Given the same initial acquisition costs, the uniform annual costs increase with the discount rate (equivalent to the interest rate).

• **Lease Rate**- the active RRF alternative is only competitive with the inactive RRF or NDF alternative at a lease rate of $5 million of higher. At $0 or $2.5 million, the active RRF is not a cost effective alternative. The lease rate effects the analysis results in an indirect way. When the assumed lease rate is lowered, the *comparative* acquisition costs for a given uniform annual costs decreases. For example, at a 10 percent discount rate, the uniform annual costs for a $40 million inactive RRF ship is 0.0457. The *comparative* acquisition costs (same uniform annual costs) for the active RRF at a lease rate of $0, $2.5 and $5 million are $127, $144 and $160 million respectively and for the NDF alternative it is $82 million. Thus for a $5 million decrease in the annual lease payments, the active RRF comparative acquisition costs decrease by $33 million ($160 less $127). This is a major difference. The $33 million could purchase another inactive RRF ship. Therefore, if the active RRF alternative is undertaken, it is important to consider the potential lease income and the acquisition costs. Otherwise, this alternative is not cost effective.

With the previous discussions, some general conclusions can be drawn concerning the preferred alternative. As stated previously, with the current best estimates for the acquisition costs of each alternatives,

the inactive RRF is the most cost effective alternative. This preference becomes stronger as the discount rate *and* acquisition costs increase. Conversely, at a lower discount rate *and* lower acquisition costs the active RRF provides the most cost effective alternative.

D. SUMMARY

Each alternative, inactive RRF, active RRF and NDF, must be evaluated based on its ability to meet the current sealift shortfalls (urgency) and provide a long term solution to the sealift problem. The alternative that provides the most sealift capability at the lowest cost is of course preferred.

The uniform annual cost analysis discussed in this chapter represents a more comprehensive approach in determining the best alternative for meeting current and future strategic sealift needs. The resulting graphs from the analysis allow for comparing each alternative, based on the annual lease rate, discount rate and acquisition costs of the ship. The results of this analysis show that each alternative is a cost effective approach to acquiring sealift assets under different values for the most critical factors: acquisition costs, lease rate and discount rate.

There are also broader financial and non-financial considerations that must be taken into account. The next

chapter discusses other factors that must be considered when choosing the best alternative.

VI CONCLUSIONS

A. BACKGROUND

Given the current sealift situation, it is critical to provide additional capacity for surge and follow-on surge shipping, as established in the MRS. It is imperative that all options for acquiring additional sealift capacity are considered equally. Chapter V stressed financial comparisons between three alternatives. As always, budget constraints will limit the number of choices available to decision makers. This makes future decisions for acquiring sealift ships that much tougher.

In this chapter specific benefits and drawbacks for each alternative are presented exploring both financial and non-financial considerations for these alternatives. These include concerns for the commercial shipbuilding and shipping industry, political environment, current status of the RRF and availability of ships in the future.

B. BENEFITS AND DRAWBACKS

This discussion is divided into six areas of interest: ship acquisition and maintenance costs, shipbuilding industry, shipping industry, ship lead time and availability, political environment and other considerations. These areas are addressed in this section

because they will have an important impact on the decisions made in the future.

1. Ship Acquisition and Maintenance Costs

Current and future budget constraints are important factors when considering the three alternatives. Traditionally, within the Navy, sealift has been a relatively low priority. The initial acquisition and conversion costs for inactive RRF ship from the current commercial market are substantially lower than the acquisition costs for the other alternatives.

An additional consideration when discussing initial acquisition costs is the provision for sale of obsolete vessels in the NDRF under section 510(i) of the Merchant Marine Act of 1936, as amended in 1977. MARAD can acquire suitable vessels for the NDRF by selling obsolete NDRF vessels. This can be accomplished by either trading the ships directly, or selling them for scrap during favorable market conditions and using the funds at a later date to acquire suitable commercial ships for the NDRF. Under the current law, these funds cannot be used for the construction of new ships, therefore they cannot be used for the active RRF or NDF alternatives. [Ref. 3: p. 11] With increased sales of the older obsolete NDRF vessels in upcoming years, funds will be available for acquiring newer RO/ROs to meet the follow-on surge requirements. This reduces the

appropriations and budgeted funds needed for ship acquisition in the near term.

The initial drawbacks of the higher acquisition costs for the active RRF and NDF alternatives must be weighed against the future benefits of deferring ship maintenance. For the active RRF, leasing would eliminate maintenance costs and provide some revenue for the government. This would increase the funds available for acquiring future ships and maintaining ships currently in the RRF and would substantially enhance military sealift responsiveness and capabilities.

2. Shipbuilding Industry

Constructing new ships in the U.S. would improve the shipyard industrial base. This would have effects throughout the U.S. economy including the steel, machine and manufacturing industries. Government revenues would rise due to increased taxable revenue from industry profits and income from the additional employed workers, and expenditures would decrease due to lower unemployed workers compensation. Conversely, under the inactive RRF alternative, there is less overall shipyard construction work. This alternative would not maintain the minimum shipyard industrial base required to meet future RRF maintenance and support needs. [Ref. 19: p. 18]

However, the argument presented for the construction of new ships in the U.S. is valid only if there is an unlimited supply of capital and labor in the markets. This is not the case. First, capital is a scarce resource. Secondly, even though the country is currently in a recession, there will not always be high unemployment in the U.S. economy. Therefore, by investing in the construction of new ships in the U.S., the government is taking capital and labor that might well be used in more efficient and profitable areas of the U.S. economy. This would have a negative impact on the economy and reduce the overall potential tax revenue for the government. Therefore, consideration for enhancing the U.S. shipbuilding industry in order to meet future RRF maintenance and support needs must be weighed against the costs for not using that capital and labor in other areas of the economy.

3. The Shipping Industry

The following discussion emphasizes several important considerations concerning the U.S. and world shipping industry:

- The RO/RO is a specialized ship that is employed in a relatively restrictive market (car carrier trades). This has two potential drawbacks:

(1) It will limit the number of RO/ROs built in the future. This reduces the number of RO/ROs that are

potentially available to replace the current and future inactive RO/ROs in the RRF.

(2) It will potentially limit the actual commercial use for the COM-20 ships (if they are built) in the future, precluding the Navy from leasing these ships.

Historically, demand for shipping is volatile. The shipping industry typically expands capacity rapidly during periods of strong market growth, only to fall into depressed periods with little demand and large over capacity. The projected demand for RO/ROs shows a modest increase into 1995. [Ref. 17] However, projecting ship demand into future years involves much uncertainty. Ten years from now, the shipping market for RO/ROs may be gone, making the COM-20 ship obsolete.

- For the inactive RRF, there is a potential future danger of relying on the commercial industry to provide RO/RO ships for the RRF. There are a limited number of U.S. commercial RO/ROs that meet military requirements for capacity and speed [Ref. 17]. In future years, when the RO/ROs currently in the RRF become obsolete, there may not be enough ships available for replacement.

Additionally, there are many potential problems when acquiring foreign vice U.S built ships for the RRF. More money must be invested to upgrade and convert the ship to meet USCG and ABS specifications. There may be future problems in maintaining these ships and obtaining spare

parts, which could greatly increase future maintenance and operating costs.

- Constructing and leasing the COM-20 ships could potentially enhance the U.S. shipping industry's position in the world trade market by providing additional U.S. ships, at lower overall construction and operating costs. U.S. ship operators leasing government vessel do not incur depreciation and other construction costs for the ships. Therefore, the shipping company can operate the ship on a more competitive basis, with lower overall costs and higher profits. [Ref. 17: pp. 14-15]

Even so, this alternative may not be economically feasible for the world shipping market. In the worst circumstance, these new ships may displace some of the existing U.S. RO/ROs actively involved in the U.S. foreign trade, particularly the charter market, destructively competing with the U.S shipping industry. A strong political backlash from the shipping industry could result. Overall, the U.S. shipping industry may oppose the concept of a 'military controlled' fleet of commercial ships.

- The maritime industry would probably prefer the NDF alternative, where privately owned ships are constructed and operated using government subsidies. The major drawback for this alternative is that these ships would not fall under government ownership.

The next section of the Defense Mobility Requirements Study (MRS) will be released soon and will address issues for sealift sustainment cargo requirements [Ref. 17: p. 1]. In this section of the MRS, breakbulk and containerships will be emphasized, where the commercial market is much larger. An active RRF approach for acquiring and operating sustainment cargo ships may become more attractive and feasible. There will also be a readily available present and future supply of commercial ships for the inactive RRF.

4. Ship Lead Time and Availability

This section addresses two issues: lead time (how soon ships can be available for sealift considering construction and conversion lead time) and ship availability (will ships be available to deliver follow-on surge cargo when needed).

a. Lead Time

Having the proper number of ships available when they are needed is of the utmost strategic importance. The MRS stipulates that additional ships for the RRF must be acquired in a timely manner to meet the follow-on surge requirements. [Ref. 17: p. 21] The inactive RRF ships can be acquired more rapidly. Conversion requires one year while new construction requires four. The larger lead time for the active RRF and NDF alternatives reduces the ability of these alternatives to meet current follow-on surge

requirements. In the near term, this greatly concerns logistics planners.

b. Availability

Availability of ships is also an issue. Since the inactive RRF ship will be outported in ROS near their designated loadout sites, the government has ready access to these ships. Thus, they can be available sooner than either the active RRF or NDF ships. This assumes that the inactive RRF ships are well maintained. If these vessels are not properly maintained, they will not perform up to standard when needed. This delays their availability (as was observed in Operation Desert Shield/Storm). In many respects, a fleet of active RRF or NDF ships can be more reliable and responsive in a national emergency or contingency. These ships will be fully operational and crewed when recalled [Ref. 17: p. 15].

It would be cost prohibitive to maintain a newly acquired inactive RRF ship in the same operational condition as an active RRF ship. Placing the ship in ROS would maintain the inactive RRF ship in an equivalent status to the active RRF or NDF ship. Unfortunately, there may not be enough funding to maintain all the present and potential RO/ROs in ROS. If funding is not available, the condition of these ships will significantly deteriorate. This was illustrated during the activations for Operation Desert

Shield/Storm. This would be unsatisfactory. It is imperative that these ships, if acquired, are properly maintained for future operations.

5. Current RRF Situation

The issue of supporting and maintaining ships currently in the RRF has not been discussed. As Operation Desert Shield/Storm proved, the state of the RRF was below that required for the ships to respond within the required time frame. The only way to maintain the RRF ships in the proper state of readiness is through increased funding for maintenance and operations.

Several RRF enhancement issues have been addressed within DOD and MARAD, including:

- Maintaining higher priority ships, such the RO/ROs, in ROS status.
- Revising current RRF lay-up and maintenance procedures.
- Increasing the activation schedule for all RRF ships.
- Improving ship spare parts inventories and controls.
- Revising ship manager contracts.
- Establishing a Civilian Merchant Marine Reserve program. [Ref. 11: pp.1-4,5]

All these initiatives will require increased funding for any significant improvement to occur. With the current and future military budgets, the funding to properly maintain the RRF will probably not be available.

This situation emphasizes the need for a centralized approach to funding and managing sealift assets. Given the funding available, the newly established National Defense Sealift Fund (NDSF) will give the Navy the flexibility to meet current and future sealift ship acquisition requirements, while maintaining the existing sealift assets in the best operational condition possible. The NDSF presents a great improvement over the current decentralized funding and operations of the military sealift program, which has lead to discontinuity and indecision within DOD and MARAD over the future direction of the sealift program.

Maintaining the trained merchant marine personnel required to man the RRF ships will continue to be a major problem. The active RRF and NDF alternatives would provide trained personnel to operate these and other RRF ships, alleviating the need for a Merchant Marine Reserve program. However, the opportunity costs of this labor must be considered. This labor is free if there is an unlimited future supply of labor. As stated previously, this is not the case. There is an opportunity cost for employing these personnel on merchant ships vice other areas of private industry. These individuals may be worth more when employed in other industries. Therefore, the question becomes whether the opportunity cost difference for using this labor

in the merchant industry exceeds the cost of training the same personnel in a Merchant Marine Reserve program.

6. The Political Environment

The political environment in the shipping industry is also important in this decision process. The Bush administration recently proposed a new operating differential subsidy program to help stem decreases in the U.S. maritime industry. Under this new proposal, the current operating subsidy program will expire within the next few years. This program would be replaced by a contingency-retainer program. This would give participating shipping companies a flat-fee payment in return for agreement to make their ships available in a national emergency or contingency. This plan would also allow shipping companies to use money currently under Capital Construction Fund programs for constructing newer ships in foreign shipyards, excluding those ships constructed in heavily subsidized foreign shipyards. Still, industry leaders want additional, tougher requirements, (e.g., legislation levying penalties against foreign owners who bring heavily subsidized ships into U.S. ports). [Ref. 24]

All these factors must be considered when evaluating the alternatives. If the U.S. government penalizes heavily subsidized foreign ships, the Navy may not be able to justify the active RRF program, since it is essentially a

government ship construction subsidy program. In addition, if future legislation significantly changes the U.S. maritime industry, an active RRF program may not be needed, since there may be a larger number of active shipping companies operating in the U.S.

7. Other Considerations

The following are additional considerations for each alternative:

- Potential problems may develop due to differences between Navy and commercial shipping industry standards for ship maintenance and operation. If the COM-20 ships are leased, the Navy may impose standards (e.g., operating, maintenance and inspections) that are too stringent for the commercial shipping industry to economically maintain. This may reduce commercial interest in these ships. Consequently, the Navy may not be able to place all the burden for maintaining the ship(s) on the lessee. This would lower lease rates.

- Additional consideration must be given to the financial health of the various ship owners and operators that undertake future active RRF or NDF ventures. If the government incurs the large up front construction costs for these ships and the ship operator cannot use the ship or the company fails, then the Navy and MARAD are responsible

for properly maintaining that ship in the RRF, creating a future drain on RRF funds.

D. CONCLUSIONS

All factors, including financial, economic and political, must be considered in determining how to acquire sealift ships. The unique dual role of the U.S. maritime industry, as a vehicle for U.S. commerce and trade and a source of shipping capability during a national emergency or contingency, continues to be a major factor in present and future military sealift planning. The future need for merchant ships is largely driven by national security needs. As the U.S. maritime industry continues its steady decline, the U.S. armed forces will have to increasingly rely on government owned shipping to carry UE and sustainment cargo wherever and whenever needed. [Ref. 25: p. 3]

The analysis presented in this thesis provides a comprehensive way to view the RRF ship acquisition decision process. The overall goal, as stressed above, is to provide the maximum capability with the minimum costs to the government. In addition, a successful RRF program must provide the necessary shipyard capability and manpower to successfully activate and operate the ships in the RRF when needed. Within the context of this analysis, it appears that the active RRF and NDF alternatives provide the best

support for the U.S. maritime industry. Yet, given the analysis results and the other issues discussed in this chapter, the inactive RRF still presents the best capability for the least costs. This conclusion is based on the following reasons:

- There is too much economic uncertainty concerning the future employment of the COM-20 ship in world trade. The active RRF alternative is only cost competitive with the inactive RRF alternative if the ship(s) is producing leasing income for the government.
- There is too much uncertainty about the political feasibility of the active RRF alternative. Current initiatives to pass legislation discouraging foreign governments from subsidizing merchant ship construction make the active RRF less feasible, since the construction of these ships would be entirely subsidized by the U.S. government.
- Inactive RRF ships can be available sooner. This meets the urgent MRS follow-on surge requirements.
- Lower acquisition costs for the inactive RRF alternative are more compatible with the current and future defense budget constraints. Additionally, the inactive RRF provides the best balance between expenditures to acquire new ships for the RRF and maintain the current RRF ships in the proper readiness condition.

With the current RRF enhancement initiatives in progress, including the increased funding for activations and maintenance and the proposed Merchant Marine Reserve program, the operational capabilities of the RRF will be further increased, providing a viable sealift force the future.

As it presently stands, the MRS notional acquisition profile purchases 18 existing commercial RO/ROs through 1996 (inactive RRF alternative). The SSIP presents an alternative acquisition profile. Under this profile, the follow-on surge requirements are met by acquiring 11 commercial RO/ROs for the inactive RRF by 1993. In later years, a new construction program (active RRF) will be used to increase RRF capability into the next century. [Ref. 17: pp. 20-22] Thus, under current plans, the active RRF program will not be implemented for several years.

APPENDIX A

GLOSSARY OF READY RESERVE FORCE SHIPS

1. **Roll-on/Roll-off ship (RO-RO)-** these ships are mainly used for surge UE and movement of other oversized equipment. Vehicles can be driven on and off ramps, normally in the stern of the ship, and for many RO-RO designs there are additional cargo areas for carrying other bulk cargo and containers. Due to their military applicability, these types of ships are currently of major concern to DOD for strategic sealift planning.

2. **Breakbulk-** this is the standard general cargo vessel. These ships are used to carry general dry cargo items. They are particularly useful for military cargo since they are equipped with on-board booms and heavy cranes for loading and unloading cargo. In addition, these ships are normally smaller than newer container ships and RO-ROs and therefore can operate in shallower ports. These ships are normally used for resupply operations.

3. **Lighter Aboard Ship (LASH)-** these ships have an on-board overhead traveling crane which is used for lifting floating barges (lighters) from the stern of the ship and then moving the barge, loaded with cargo, to the proper hold

for storage. These ships are used mainly for transport of bulk, sustainment cargo.

4. SEABEE Ship- this type of ship is different from the LASH in that the barges are lifted by an elevator, in the stern of the ship, where they are then moved to different deck levels for storage. These ships are also used for carrying sustainment cargo.

Note that both the LASH and SEABEE ships are essentially self sustaining in that they do not require pierside cranes to load or unload their cargo (barges), unlike standard container ships. Only two to three tug boats are required to transport the floating barges to and from the ship during loading and unloading.

5. Auxiliary Crane Ship (TACS)- these are modified container ships equipped with heavy lift cranes. These ships are used in conjunction with non-self sustaining ships, such as container ships, to help off load cargo in forward deployed areas. They are capable of off-loading various types of cargo. Additionally, the TACS are often equipped with sealift enhancement features (flat tracks and sea sheds) and are able to carry a large amount of cargo.

6. Tankers- there are eleven tankers in the RRF capable of carrying different types of liquid cargo. Several of these tankers are also able to perform underway replenishment.

7. Troopships- there are two troopships in the RRF. These are normally used to deliver augmented forces to the forward deployed areas. [Ref. 1: pp. 36-37]

8. Aviation Logistics Support Ship (TAVB)- two RO/RO / Containerships that are under commercial contract to MSC. Each ship carries an Intermediate Maintenance Activity (IMA) to support deploying MEB aviation units.

9. Hospital Ships (TAH)- two ships, one on the East coast and one on the West coast, assigned to MSC and operated by civilian crews. These ships are used in forward deployed areas to provide medical support for forces in theater.

APPENDIX B

U.S. SHIP CONSTRUCTION SUPPORT PROGRAMS

Simple economics is the reason behind the need for subsidies in the U.S. maritime industry. There is generally a large disparity of labor costs between the U.S. and other nations of the world, particularly third world and less industrialized countries. Therefore, when constructing a merchant ship in a U.S. vice foreign shipyard, the only way the U.S. shipyard can compete on a cost effective basis is through higher productivity or government subsidies.

Since the end of World War II no area of the U.S. maritime industry has been harder hit than shipbuilding. The continued operation of many heavily subsidized foreign shipyards and the reduction of U.S. subsidies for shipbuilding has essentially eliminated commercial merchant ship construction in U.S. shipyards.

A ship operator wishing to acquire a new ship can choose between constructing a ship in a foreign or U.S. shipyard. The decision will affect the method of financing for the ship construction and the overall capital costs. A major factor underlying a ship operator's choice is the relative financial strength of the shipbuilding company and the level of financial support the company can receive from the U.S. government.

The ship operator can choose to construct the new ship in a foreign shipyard and raise the necessary capital through a commercial bank loan or equity financing. In general, if the ship operator is unable to raise the necessary capital, the second alternative is to apply for U.S government assistance. The three main forms of U.S. maritime ship construction support include: the Construction Differential Subsidy, the Federal Ship Financing program (Title XI), and the Capital Construction Fund Program. The following is an overview of each program:

1. Construction Differential Subsidy

The Construction Differential Subsidy (CDS) program was established under the Merchant Marine Act of 1936 and amended by the Merchant Marine Act of 1970. It provides federal subsidies for ships constructed in U.S. shipyards and used in U.S. foreign trade. The proposed ship must meet approved engineering and construction standards, including features that make the ship militarily useful (National Defense Features). MARAD, upon review of the ship construction proposal, will approve the construction of the ship and determine the amount of subsidy through either negotiated contract, or the difference between a U.S. competitive bid and the lowest foreign cost bid for an equivalent vessel. [Ref. 15: pp. 94-95] [Ref. 16: pp. 468-

470] As of 1983, the CDS was suspended and the program is not used by the U.S. commercial shipping industry.

2. Federal Ship Financing Program (Title XI)

Under the Federal Ship Financing program the U.S. government will fully guarantee the debt obligations issued by a U.S. shipping company when used to finance commercial ship construction. This guarantee enables the company to obtain a high AAA credit rating, thus providing the following benefits:

- Lower interest Rates on debt obligations.
- Longer financing terms (up to 25 years).
- No requirements of personal guarantees by the ship's owners.

If the shipping company should default on the debt obligation, Title XI guarantees full payment of all interest and unpaid principal. If this should occur, MARAD will take control of the vessel, where it is placed in the NDRF until it can be sold at some future date.

The amount that is guaranteed by the government is based on the actual costs of the ship. When the vessel is built using CDS, the government will guarantee up to 75 percent of the vessel's capitalized costs. If CDS is not used, then 87.5 percent of the capitalized costs are guaranteed. [Ref. 15: pp. 95-96]

3. Capital Construction Fund

The Capital Construction Fund (CCF) was authorized under a 1970 amendment to Section 607 of the Merchant Marine Act of 1936. Though the terms of CCF can get complicated, in general they allow the shipping company to accumulate the capital needed for future ship construction. This is done through a method of Federal income tax deferrals on money or other property that can be used for the purchase of qualified ships built in the U.S. and for the repayment of debt used to finance the acquisition of these qualified ships.

The shipping company can establish a CCF account in the bank of its choice. Deposits into the fund have a maximum and minimum requirement: the maximum limit is set to control the resulting tax deferment used by the company; the minimum limit is set to ensure a sufficient amount of funds are on deposit to accomplish the CCF objectives.

Deposits are made into one of three different accounts under CCF, depending upon the type of funds deposited:

1. Deposits into the Ordinary Income Account are from income that would have been taxable to the company. This allows the company to reduce their total tax liability by the amount deposited into the fund.

2. Deposits into the Capital Gains Account are funds that would have otherwise been taxed at the current capital

gains rate. This allows the company to defer those taxes until the funds are withdrawn at a later date.

3. Deposits into the Capital Account include items, such as depreciation, that are not taxable. This allows the company to invest these funds and defer the tax on any earnings or gains from the investments in the account, since all earnings and gains from fund deposits must be deposited back into the fund. [Ref. 15: pp. 96-102]

As the fund account levels increase, the company can make qualified withdrawals to finance the construction of a new ship or make payments on debt incurred to acquire an existing ship under CCF. Qualified withdrawals are subjected to special tax considerations linked with the ship acquisition. Non-qualified withdrawals can also be made. These withdrawals are generally subjected to the regular tax rates for the company.

APPENDIX C

NET PRESENT VALUE AND UNIFORM ANNUAL COST

A. DISCUSSION

The problem in any capital investment decision is determining which alternative provides the best combination of value (not necessarily monetary value) and cost. When evaluating the financial feasibility of capital investments there must be decision rules to help the manager choose between alternatives A method commonly used to assist a manager's decision process is the Net Present Value (NPV) model.

The NPV model is often used by managers to help estimate the relative profitability of capital investment alternatives. The NPV model summarizes the economic value of an alternative in a single dollar amount as of a given point in time. [Ref. 18: p. 591] For the NPV model, the following factors must be taken into account:

- Future cash flow estimates.
- Replacement decisions.
- Discount rates.
- Effects of inflation.
- Sale/scrap values at the end of useful life for an asset.

The cash flows for a particular investment are the differential, or incremental, cash flows that will occur if the particular investment is undertaken, as opposed to the

'status-quo', or current situation. Non-incremental costs should not be included in the analysis since they will be incurred regardless of the decision made. Sunk costs should not be considered for the same reason.

Decisions concerning future replacement costs must also be considered for alternatives with different economic or useful lives. For example, if one alternative has a ten year useful life while another has a 20 year useful life, then the costs for replacing the first alternative at the ten year point must be taken into account. However, the purpose of calculating uniform annual costs (for this thesis) is to compare alternative investments with different useful lives. Therefore, replacement costs are not factored into these calculations.

Finally, any scrap or sale value for an asset at the end of useful life should also be included in the NPV calculations. This should reflect the market value of the asset at the time of sale or scrap.

The basic structure of the NPV model is simple. The equation for NPV is as follows:

$$NPV = \sum_{n=0}^{N} C_n \times (1+d)^{-n}$$

where C_n=Cash inflows or outflows at the end of period n.
d= the discount rate.
n= the time period the cash flow occurs.
N= overall time period of the investment, normally in years.

The setup for the analysis is described as follows:

- Estimate all future cash flows, both inflows and outflows.

- Find the present value of each cash flow by discounting at the prescribed discount rate.

- Sum the discounted cash flows, which gives the NPV of the project.

- If an investment has a positive NPV, it should be undertaken: if it is negative, it should be rejected. With alternative investment decisions, the investment with the highest NPV should be chosen, provided the investment(s) is within set budget constraints.

The standard NPV analysis will divide the future cash flows into four general categories; investments, periodic inflows and outflows, depreciation tax shield and disinvestment (scrapping or selling the asset at end of useful).

Tax considerations are taken into account for NPV analysis because it is the company's net after tax cash inflow or outflow that effects the bottom line. However, this thesis considers an investment by a public organization (government), not a private organization. Therefore, tax factors are not included in the analysis.

Depreciation is important for a company because it has a direct effect on the company's taxes. Depreciation is not a

cash flow, but an allocation of investment costs to the periods when benefits for that asset are incurred. What is important when considering depreciation is the differential cash flow due to the depreciation tax shield of the new investment and any depreciation tax shield foregone due to the retirement of an old asset. Since the public organization does not pay taxes, depreciation is not incorporated into this analysis.

An important factor in the NPV analysis is the timing of cash flows. This is due to the effect of discounting on those future cash flows (time value of money). Simply put, a dollar today is worth more than a dollar sometime in the future. For each dollar at hand there are alternative investment opportunities, and thus a chance to earn some interest rate, or return, over a period of time. Also, the fact that inflation reduces the value of money year to year is a factor in the time value of money.

To factor in the effects of the time value of money, the future cash flows for a given investment are adjusted to their present value at a given discount rate. This discount rate will vary depending upon the current economic conditions and the rate of inflation. This will affect the rate of return on alternative investments and hence the NPV. Generally, the discount rate that is used is the cost of borrowing the necessary capital to undertake an investment.

Thus, if an investment has an NPV of zero, it provides enough return to recover the costs of the initial investment and the borrowing costs (interest costs), plus any operating costs incurred. This assumes that there is an unlimited supply of capital in the market. Since this is not the case, the opportunity costs of capital must also be considered in the discount rate. The discount rate used under any NPV situation will ultimately effect the final capital investment decision.

The NPV model is useful because it allows a manager to view the costs of one investment relative to other alternative investments. The project that allows the largest NPV and the best capability, or capacity, is generally the one to be considered. The NPV model can also be applied to lease or buy decisions. In this case, the alternative with the smallest present value for the cash outflows (discounted cash flows) is considered the best.

B. NET PRESENT VALUE AND UNIFORM ANNUAL COST EXAMPLE CALCULATION

The active RRF (COM-20) example calculation is discussed here to describe how the NPV and uniform annual costs were calculated. The spread sheet is set up in four basic categories: investment (or acquisition cost), operating cash flows (leasing income, or operating subsidies), maintenance

and disinvestment. This example calculation was done at a 10 percent discount rate.

The cash flows for ship construction begin in year zero and continue until year three, at the payment rate discussed previously. These cash flows are discounted to give their present value. At a 10 percent discount rate, the present value of $200 million spent over four years at the predetermined rate is $154.66 million.

In year four, the ship is leased to a commercial shipping company. This continues until year 18 (for a total of 15 years) when the ship is then placed in the RRF. To determine the present value for those 15 year annual lease payments, the present value factors for years four to 15 are summed (5.7145) and then multiplied by the $5 million annual lease payments. The present value of the lease income is $28.57 million.

The same is done for the costs of maintaining the ship in ROS in the RRF from years 19 to 43 (25 years). The present value factors for those years are summed and then multiplied by the annual ROS costs ($3.742 million) and the annual costs for the required merchant marine reserve personnel ($101,200). These present values are $6.128 million and $165,730 respectively. This example shows that deferring costs for maintaining ships in the RRF to the

distant future (greater than 19 years) significantly reduces the present value of those costs.

Finally, the ship is scrapped in year 44. The cash inflow is $2 million, but after 44 years the present value is only $30,000.

The next step in the calculation is to sum the present values for the cash inflows and outflows in each year, which gives the NPV. In this example, the NPV is $131.85 million. The last step in the calculation is to determine the uniform annual cost. This is done by dividing the NPV by the sum of the discount factors over the ship's useful life (44 years). The uniform annual cost in this calculation is $12.15. This cost is then divided by the square feet of cargo capacity for the ship (240,000) to normalize the calculation in terms of units. The final calculation is $0.0506 ($M/K-sq-ft).

Sample spreadsheets are also shown for the inactive RRF and NDF alternatives.

TABLE 13. ACTIVE RRF NPV EXAMPLE CALCULATION
(10 % DISCOUNT RATE). Page 1 of 5

($ Millions)

Year	0	1	2	3	4	5	6	7	8	9
Investment										
Build Ship (payment rate)	18%	33%	35%	14%						
Amount- $200M	-36	-60	-57.85	-21.04						
Leasing income ($5 million annually)					5	5	5	5	5	5
Maintenance ROS										
(after lay-up at 18 years)										
Merchant Marine Reserve Costs										
(22 personnel at $4600/person)										
Vessel Scrap										
($50 per ton x 40,000LT)										
Total cash flow	-36	-60	-57.85	-21.04	5	5	5	5	5	5
Present value factor (10%)	1	0.9091	0.8264	0.7513	0.683	0.6209	0.5645	0.5132	0.4665	0.4241
Present value	-36	-54.546	-47.80724	-15.807352	3.415	3.1045	2.8225	2.566	2.3325	2.1205

PVF Sum= 10.85
NPV= (131.8517)
Uniform Annual Costs/K-SQ-FT= (0.0506)

PV of ROS cost= (6.13)
PV of reserve costs= (0.17)
PV of leasing income= 28.57
PV of scrap= 0.03

TABLE 13. ACTIVE RRF NPV EXAMPLE CALCULATION
(10 % DISCOUNT RATE). Page 2 of 5

10	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*
5	5	5	5	5	5	5	5	5				
									-3.742	-3.742	-3.742	-3.742
									-0.1012	-0.1012	-0.1012	-0.1012
5	5	5	5	5	5	5	5	5	-3.8432	-3.8432	-3.8432	-3.8432
0.3855	0.3505	0.3186	0.2897	0.2633	0.2394	0.2176	0.1978	0.1799	0.1635	0.1486	0.1351	0.1228
1.9275	1.7525	1.593	1.4485	1.3165	1.197	1.088	0.989	0.8995	-0.6283632	-0.57109952	-0.51921632	-0.47194496

TABLE 13. ACTIVE RRF NPV EXAMPLE CALCULATION
(10 % DISCOUNT RATE). Page 3 of 5

23	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*
-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742
-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012
-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432
0.117	0.1015	0.0923	0.0839	0.0763	0.0693	0.063	0.0573	0.0521
-0.4496544	-0.3900848	-0.35472736	-0.32244448	-0.29323616	-0.26633376	-0.2421216	-0.22021536	-0.20023072

TABLE 13. ACTIVE RRF NPV EXAMPLE CALCULATION
(10 % DISCOUNT RATE). Page 4 of 5

32	33	34	35	36	37	38	39	40
-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742
-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012
-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432
0.0474	0.0431	0.0391	0.0356	0.0323	0.0294	0.0267	0.0243	0.022095
-0.18216768	-0.16564192	-0.15026912	-0.13681792	-0.12413536	-0.11299008	-0.10261344	-0.09338976	-0.084915504

TABLE 13. ACTIVE RRF NPV EXAMPLE CALCULATION (10 % DISCOUNT RATE). Page 5 of 5

41	42	43	44
-3.742	-3.742	-3.742	
-0.1012	-0.1012	-0.1012	
			2
-3.8432	-3.8432	-3.8432	2
0.02009	0.01826	0.0166	0.01509
-0.077209888	-0.070176832	-0.06379712	0.03018

TABLE 14. INACTIVE RRF NPV EXAMPLE CALCULATION
(10% DISCOUNT RATE) Page 1 of 3

($ Millions)

Year	*0*	*1*	*2*	*3*	*4*	*5*	*6*
Investment							
Purchase/Convert ship (1 year)	-40						
Maintenance (ROS)		-3.742	-3.742	-3.742	-3.742	-3.742	-3.742
Merchant Marine Reserve Costs							
(22 personnel at $4600/person)		-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012
Vessel Scrap							
($50per ton x 40,000LT)							
Total cash flow	-40	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432
Present value factor (10%)	1	0.9091	0.8264	0.7513	0.683	0.6209	0.5645
Present value	-40	(3.4939)	(3.1760)	(2.8874)	(2.6249)	(2.3862)	(2.1695)

PVF Sum= 10.08
NPV= (74.3650)
Uniform Annual Costs/K-SQ-FT= (0.0461)

PV of ROS costs= (33.6398)
PV of reserve costs= (0.9098)
PV of Scrap= 0.1846

TABLE 14. INACTIVE RRF NPV EXAMPLE CALCULATION.
(10% DISCOUNT RATE) Page 2 of 3

7	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742
-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012
-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432
0.5132	0.4665	0.4241	0.3855	0.3505	0.3186	0.2897	0.2633	0.2394
(1.9723)	(1.7929)	(1.6299)	(1.4816)	(1.3470)	(1.2244)	(1.1134)	(1.0119)	(0.9201)

TABLE 14. INACTIVE RRF NPV EXAMPLE CALCULATION.
(10% DISCOUNT RATE) Page 3 of 3

16	17	18	19	20	21	22	23	24	25
-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	
-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	
									2
-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	2
0.2176	0.1978	0.1799	0.1635	0.1486	0.1351	0.1228	0.117	0.1015	0.09229
(0.8363)	(0.7602)	(0.6914)	(0.6284)	(0.5711)	(0.5192)	(0.4719)	(0.4497)	(0.3901)	0.18

TABLE 15. NDF NPV EXAMPLE CALCULATION.
(10% DISCOUNT RATE) Page 1 of 5

($ million)

Year	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Investment								
Build Ship (payment rate)	18%	33%	35%	14%				
Amount- $104	-18.72	-34.32	-36.40	-14.56				
Annual Operating Subsidy					-0.075	-0.075	-0.075	-0.075
Maintenance								
(after lay-up at 18 years)								
Merchant Marine Reserve Costs								
(22 personnel at $4600/person)								
Vessel Scrap								
($50 per ton x 40,000LT)								
Total cash flow	-18.72	-34.32	-36.4	-14.56	-0.075	-0.075	-0.075	-0.075
Present value factor (10%)	1	0.9091	0.8264	0.7513	0.683	0.6209	0.5645	0.5132
Present value	-18.72	(31.2003)	(30.0810)	(10.9389)	(0.0512)	(0.0466)	(0.0423)	(0.0385)

PVF Sum= 10.854
NPV= (97.6324)
Uniform Annual Costs/K-SQ-FT= (0.0562)

PV of operating subsidies= (0.4286)
PV of ROS costs= (6.1273)
PV of reserve costs= (0.1657)
PV of scrap= 0.03018

TABLE 15. NDF NPV EXAMPLE CALCULATION.
(10% DISCOUNT RATE) Page 2 of 5

8	9	10	11	12	13	14	15	16	17	18
-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075
-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075	-0.075
0.4665	0.4241	0.3855	0.3505	0.3186	0.2897	0.2633	0.2394	0.2176	0.1978	0.1799
(0.0350)	(0.0318)	(0.0289)	(0.0263)	(0.0239)	(0.0217)	(0.0197)	(0.0180)	(0.0163)	(0.0148)	(0.0135)

TABLE 15. NDF NPV EXAMPLE CALCULATION.
(10% DISCOUNT RATE) Page 3 of 5

19	20	21	22	23	24	25	26	27	28
-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742
-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012
-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432
0.1635	0.1486	0.1351	0.1228	0.117	0.1015	0.0923	0.0839	0.0763	0.0693
(0.6284)	(0.5711)	(0.5192)	(0.4719)	(0.4497)	(0.3901)	(0.3547)	(0.3224)	(0.2932)	(0.2663)

TABLE 15. NDF NPV EXAMPLE CALCULATION.
(10% DISCOUNT RATE) Page 4 of 5

29	30	31	32	33	34	35	36	37
-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	-3.742
-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012
-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432
0.063	0.0573	0.0521	0.0474	0.0431	0.0391	0.0356	0.0323	0.0294
(0.2421)	(0.2202)	(0.2002)	(0.1822)	(0.1656)	(0.1503)	(0.1368)	(0.1241)	(0.1130)

TABLE 15. NDF NPV EXAMPLE CALCULATION.
(10% DISCOUNT RATE) Page 5 of 5

38	39	40	41	42	43	44
-3.742	-3.742	-3.742	-3.742	-3.742	-3.742	
-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	-0.1012	
						2
-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	-3.8432	2.00
0.0267	0.0243	0.02209	0.02009	0.01826	0.0166	0.01509
(0.1026)	(0.0934)	(0.0849)	(0.0772)	(0.0702)	(0.0638)	0.03

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